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ABSTRACT

A new interactive model of attention, perception, memory, and arousal is introduced; and its use in assessing characteristics of the perceptual process is demonstrated. The principal concern is not the presentation of new data; rather it is placement of existing psychological data within a new context. Topics discussed include: attention as an instinct, attention and motivation, and attention as vigilance. The new theoretical perspective reflects a belief that the most fruitful approach to understanding human experience and behavior is to begin with the perceptual process itself, and for analysis of personal-environmental interaction to take place within an evolutionary perspective. The developed theory relates questions of attention, affect, and learning explored in this paper to others of, for instance, cognitive style, personality, intelligence and creativity, and abnormal behavior. The analysis suggests a need for a shift in balance from the current cognitive bias in learning theory and educational research toward a greater consideration with biological and physiological factors. Theoretically, the model points to the need to place more emphasis on the total environment. Methodologically, the theory emphasizes the subjectivity of attention, affect, and learning. Practical implications of the model focus on the deliberate use of attention devices as tools for more effective teaching and learning. (TJH)

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ATTENTION, AFFECT and LEARNING

Jane Gear
1987

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UNIVERSITY OF HULL

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This is paper number thirteen in the Newland Paper series, planned primarily to publish the work of members of staff and research students of the Department of Adult and Continuing Education. "Newland" is the name of the district in Hull in which the University is situated.

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PREFACE

The aims of this paper are to introduce a new interactive model of attention, perception, memory and arousal (APM-A) and to show, on the one hand, how this can be used to reveal characteristics of the perceptual process not generally taken into account in established theories of attention and, on the other, to stand within a unifying framework major theories of attention and learning conventionally regarded as incompatible. The principle concern, therefore, is not with the presentation of new data, but with a new context within which to stand existing psychological data.

It is argued that, not only are attention, perception, memory and arousal wholly interactive, but so are affect and cognition. Attempts to investigate each in isolation from the others are therefore seen to provide only a limited, if not distorted, understanding of what is seen to be a continuous, lifelong, organic and developmental process which nevertheless subsumes a capacity for mechanistic modes of behaviour. Quite apart from its influence on other aspects of learning, it is argued that emotion - as a crucial instinctive element of the orientation reflex - is present at the very moment of perception and is therefore instrinsic to cognition, to thinking and knowing.

In sum, the new theoretical perspective reflects a belief that the most fruitful approach to understanding human experience and behaviour is to start with the perceptual process itself, and for analysis of person-environment interaction to take place within an evolutionary perspective. Essentially, what follows is an introduction to a unifying framework called APM-A theory. This is seen to allow greater complexity of human functioning to be taken into account than formerly so that human adaptability in general - as well as specific kinds of learning in specific situations - can be explored more fully within the context of human variability.

The developed theory, which relates the questions of attention, affect and learning explored in this paper to others of, for instance, cognitive style, personality, intelligence and creativity, and so-called 'abnormal behaviour', is the subject of a forthcoming book Perception and the Evolution of Style: a new model of man, to be published by Routledge and Kegan Paul (Spring 1988).

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1 HIDDEN COMPLEXITIES

1.1 Introduction and Rationale

The necessary linking of attention and perception,[1] memory and attention,[2] attention and arousal[3] and attention and consciousness,[4] together with the knowledge that interest in attention is expressed in disciplines as far removed as anthropology, industrial psychology, philosophy, sociology neuro-physiology and religion, suggests the crucial role it plays in mental life as well as hinting at its complexity. Moreover, the fact that it is possible to predict that most ready attention will be given, and most vivid perception and memory registered, in relation to emotionally charged events further suggests that attention, perception, memory and emotion - which will be defined later as dependent on arousal - are extremely closely related.

By adopting an evolutionary perspective it will in fact be shown that they are wholly interactive. It will also be shown how it is possible to provide a holistic view of their interaction based on some of the effects of physiological arousal on human psychology: effects resulting both from our internal states and our interactions with objects, places, other people and ideas. It is to be argued that focused attention and learning actually result primarily from deeply instinctive reactions to environmental events[5] and the degree to which particular 'events' affect the organism.

Although some aspects of attention have been extensively researched and analysed in a wide range of disciplines, the topic is one which has so far been largely ignored, taken for granted, or the subject of only passing interest to those most obviously concerned with learning, i.e. educationists. When attention is a subject of concern to either educational psychologists or teachers it is most often with reference to problems of maintaining attention;[6] and, even then, it is usually viewed as being under conscious control and normally available on request. Teachers, in particular, talk

a great deal about the need to 'pay attention'. They do acknowledge that there may be an 'inability to pay attention', or that a child may be 'lacking in concentration' but, again, the implication tends to be that the problem is entirely that of the student or pupil concerned. Vigilance researchers have shown however, as will be reported, that problems of sustaining attention are not just a characteristic of wilful schoolchildren, nor are they confined to those mature students who are inclined to interpret such difficulties, along with deficiencies in memory, as an inevitable effect of ageing.[7]

Because attention, perception, memory and arousal are usually considered in isolation, or paired with one or another aspect of consciousness, many of the complexities of their relationship with each other become confused or remain unexplored. For instance, although perception could be defined as the interpretation of a signal, attention as the degree of concentration the signal commands, arousal as excitement experienced on its recognition, and memory the ability to recall it, the temporal order of attention and perception can easily be disputed. It can be argued that it is necessary to perceive before it is possible to attend; just as it can be argued that it is not possible to perceive any signal unless it is attended to first. Equally, memory may refer to the ability to register, retain and recall information, but it must also be active during the interpretation of sense data in order to recognise the change in the environment which constitutes a signal; and disagreement is widespread over the question of whether attention, memory or perception is responsible for the selection of information.[8]

The conventional view of the relationship between attention, perception, memory and arousal may be described as linear:

attention
↓
perception
↓
thought
↓
feeling
↓
memory

It will be argued, however, that these reactions to events and information occur not as consecutive and separate processes but as simultaneous and interactive aspects of the same process:

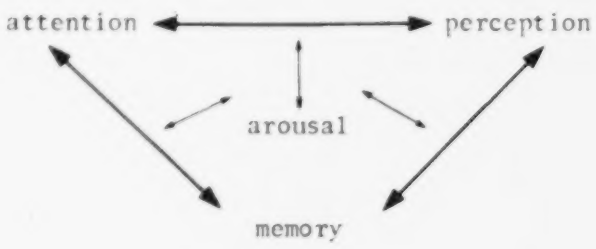


Figure 1 APM-A: a model adopted to represent the interactive relationship between attention, perception, memory and arousal which results in the acquisition of sensory experience, which, at levels of conceptual organisation and skill improvement, is recognised as learning. A process described in detail in chapter 2.

It has already been implied, in connection with instinct and in respect of the ways in which teachers often regard attention, that unconscious or sub-threshold (of consciousness) factors must be taken into account as well as the super-threshold or conscious events usually described. In addition, because we known from experience, and even without research data - the best known of which is summarised in George Miller's paper 'The magical number seven, plus or minus two'[9] - that our attention has only limited capacity, it can be assumed that selection of environmental events has to take place; and as information is continuously bombarding the senses it must also have to take place at sub-threshold level - first. In fact the position being adopted is that most of our behaviour is unconsciously performed: that the

majority of our responses are automatic - necessarily routinised because of our limited capacity of attention - and that conscious attention, given as a result of acknowledged motivation or as attention paid on command, although of obvious concern to the teacher, may therefore be less important than appeal made to unconscious or sub-threshold mechanisms of mind and instinct. To recognise conscious motivation and interest only is to ignore (a) the well known and widespread practice of self deception: an aspect of perceptual defence[10] which may for instance be responsible for an individual offering himself as highly motivated to learn, when in fact he is highly motivated - but to socialise; and (b) our unconscious tendencies to classify and 'stereotype'[11] what is about us, both of which factors are frequent causes of miscommunication and misunderstanding.

1.2 Characteristics of Attention

Four major dimensions of attention are defined below. These definitions are intended to emphasise the importance of some commonly ignored complexities and, at the same time, begin to provide a framework within which the interactive APM-A model can be more fully explored and developed.

1.21 internal ——— external

The most consistently recognised aspect of attention is that it has two major characteristics. Underwood mentions "the two main functions of attention" as being "information selected from the environment" and "information retrieved from memory".[12] Berlyne,[13] and Kahneman[14] after him, refer to "intensive" and "selective" attention. By "intensive" attention Berlyne meant determining the "degree of alertness or vigilance", and by "selective" attention, "which elements of the vigilance field will exercise a dominating influence over behaviour". By contrast, Mackworth quotes Eastern science and Indian teachers in particular, as identifying

"... processes occurring between the object and its apprehension by the conscious mind",[15] and her phrase "joining mind ... to sensations"[16] seems to be a good one to express the fact that attention is composed of both internal and external events.

1.22 given ——— gained

Not a conventional dimension of attention, but one which will be seen to relate to the conscious ——— unconscious dimension which assumes some importance in what follows. Attention 'given' refers to attention given as a result of conscious motivation or interest - or command - whereas attention 'gained' refers to attention commanded by environmental events or the state of the organism, and gained, more or less reluctantly, in response to priority signals.[17]

1.23 conscious ——— unconscious

This characteristic of attention is probably the most neglected by attention and learning theorists, although it is of course well recognised by certain religious sects, mystics and psychotherapists. Reference to perceptual defence can be found under both perception[18] and memory,[19] but the phenomena of repression[20] and latent learning,[21] as other unconscious aspects of attention, are usually referred to as aspects of memory or learning only. Most common oblique references to unconscious elements of attention are made in discussion of selection and routinisation, but even the topic of routinisation, paradoxically, is most often referred to under the heading of 'Consciousness'.[22]

1.24 scanning ——— focus

This must be the most widely experienced characteristic of attention which has an obvious and direct relationship with concentration. It may

otherwise be referred to as 'wide' or 'narrow' attention, as 'divided' or 'full' or as 'general' or 'specific'. Crucial to the theoretical construct to be developed is the fact that scanning and focus are viewed as taking place at both conscious and unconscious levels of mental activity, and that sub-threshold (of consciousness) monitoring of environmental events is continuous.

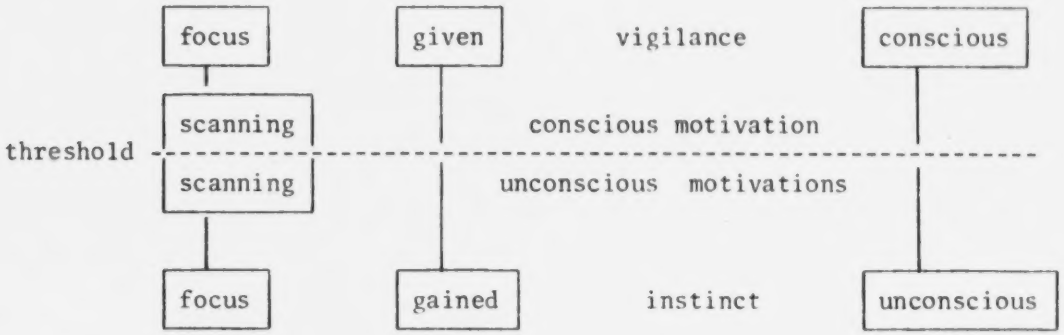


Figure 2 Characteristics of attention to be taken into account, beyond the conventional internal ——— external dimension, and in addition to its conscious attributes.

1.3 Methodology and Outline

Because the complexities of attention make it an area of interest in so many different fields it would be quite impossible to review all of the literature connected with it within the space available in this paper, therefore major work is referred to in the chapters to which it is appropriate.

In developing the APM-A view the methodology has been to become acquainted with and evaluate major vigilance and attention theories, and relate the outcomes of this exercise to the analysis of how attention has been treated by major learning theorists. These findings are offered and interpreted in terms of the new perspective outlined in chapter 2, Attention as Instinct, which draws on evolutionary ideas as well as

information processing theories, Gestalt psychology of perception, and Piagetian developmental psychology, to present a theoretical construct (APM-A ——→ Verstand). This emphasises the predominance of instinctive responses to changes in the environment - and in the state of the organism - whilst stressing the importance of the senses and emotion in learning. Chapter 2 is concerned mainly with attention gained as a result of 'unconscious effort'[23] subject to conscious resistance, and attention functioning both as scanning and focus (see Figure 2).

Chapter 3 presents attention as an unavoidable concept of learning, and uses the new construct to show how major learning theorists deal with the inconvenience and subjective implications of such a concept whilst sometimes strenuously denying its existence. This chapter also illustrates how the APM-A ——→ Verstand construct, within which major schools of learning are related to each other, can also be used to clarify the often confused relationship between motivation, drives and interest. As a discussion of attention and motivation chapter 3 is mainly about the effects of internal states of the organism on attention and learning. The characteristics of attention defined in Figure 2, and above, which are most relevant to this chapter are attention both 'given' and 'gained', and both conscious and unconscious; but focus assumes more importance than scanning.

Attention as Vigilance, chapter 4, examines problems of maintaining attention and therefore refers mostly to the effects of external events upon the organism. It will be seen that major findings and theories can be related to one another within an evolutionary perspective, just as signals most readily attended to bear an obvious relationship to their survival value, or the level of threat heralded by them. Here the dominant theme is attention as neither given nor gained - but required: as conscious effort subject to unconscious resistance and involving both scanning and focusing functions.

Finally, in an attempt to illustrate the fact that theoretical advance affects different levels of understanding and activity and in order to relate theory to practice, in chapter 5 some implications of the APM-A view are briefly offered under the headings of 'paradigmatic', 'theoretical' 'methodological' and 'practical' implications. But, above all, as complex and highly interactive processes, learning, and indeed teaching, are seen to be about the emotional involvement of individual (and therefore variable) organisms, and the effects of total (and therefore variable) environments.

2 ATTENTION AS INSTINCT

2.1 Perception and Purpose

Oatley, in his study of the theoretical bases of brain research and perception, quotes Bartlett's references to cognitive schemata being dependent on social and cultural backgrounds and goes on to say,

> ... we must notice that this is a world of objects which might have uses which might fit with our purposes, of people with whom we might interact, of space in which we might move. It is a world with possibilities for action, described by us and seen by us, in terms of the ways we might interact with it.
>
> In other words the way we see is in terms of our human purpose within the environment.[1]

The APM-A view rests on the assumption that the fundamental "purpose" of all living organisms is to adapt to perceptible change in the environment and to survive, both as individuals and collectively as members of species. To do this it is necessary to be able to recognise and identify potential threat, not only of an immediate kind to the individual, but also, in the case of the human species, long term and/or indirect threats posed to 'significant' other individuals and/or groups on whom there is some degree of physical or emotional dependency.

In order to be able to anticipate the short or long term outcomes of environmental events Homo sapiens must learn. As a species we must be able to draw upon past experience of similar and/or related signals and use the feedback gained from our relationships with them. In turn, this learning must be applied to new situations. In fact, a reasonable definition of intelligence might be: the ability to cope effectively with new situations. We are all tuned to cope with novel situations - to cope with change - but it is suggested that the most intelligent rise most effectively to this fundamental challenge.[2]

Feedback, in the form of our perceptions of the effect of our actions on the object of attention, becomes in turn a change in our own state of knowledge. It is this accommodation of experience and knowledge acquired, and the adaptation and adjustment to our surroundings which it constitutes, which we call learning.

Sometimes it is gained by a direct relationship with the world, when we normally refer to it as experience, and sometimes by proxy, through the knowledge and/or insights of others, i.e. through the written or spoken word. This feedback, as knowledge of the results of our performance, which we receive from others or some object of attention, either has some effect upon us or not. If it arouses us sufficiently[3] we not only remember, but we relate it to other experiences, in which case learning is likely to be more permanent than if we had no previous or related knowledge of the event, or if it had no relevance to our particular "purpose" as individuals or to "our particular social or cultural background",[4] or, as emphasised here, bore no relationship to the most fundamental purpose of all - survival. It may also be accepted, or even follow, that we learn most successfully from those events to which we give full attention. Certainly, divided attention, as lack of concentration is very frequently cited as a source of learning problems.

It is this complex process of registration, retention and availability for recall (or not) in the short or long term, depending upon the intensity of our interest in an event, i.e. how we perceive it and the quality of attention given or gained, which is being called APM-A. Further, it is being suggested that the activation of the APM-A process is stimulated by signals which occupy a hierarchy of attention value. If Maslow's hierarchy of needs is accepted,[5] within which basic and survival needs are the first to be satisfied, it would seem reasonable to suggest that signals related to survival needs also enjoy priority for attention.

Our instinct for survival is mediated by our senses, i.e. exteroceptors: sight, hearing, smell, taste and touch, and interoceptors, mainly of the viscera, which act in connection with cortical responses to direct and change attention. Underlying the direction of attention, and the mechanisms through which the senses act, is emotion - defined below (3.3) as a combination of mental and physical events, cognition and arousal - the element being viewed as crucial to how effectively we learn.

In psychological terms, we are constantly processing information received through the senses which may or may not be consciously perceived or registered. It is to be argued that the amount of attention we pay to any event or item of information is dependent upon its value to the organism; its survival value first, in terms of inherent threat, and only secondly (and in the wake of psychoanalytic theory - surprisingly to some) in terms of sexual connotations, and inherent 'promise'. These two priorities will override any other value it may have, or in fact any less vital signal which may arrive concurrently. Therefore information transmitted by an exceedingly rich and complex environment has to be perceived and made sense of as quickly and as efficiently as possible, in case swift action is required.

Mechanisms responsible for this kind of orientation apparently also serve to reduce conflict[6] and/or anxiety arising from ambiguous, unrecognised, or difficult to identify, stimuli. Such mechanisms rapidly draw together all hitherto related experience and knowledge of an event and may even 'fill in'[7] detail, appropriately or not, in order to make a satisfactory classification. On these and other grounds it is argued below that Gestalt laws of perceptual organisation[8] with reference to proximity, similarity, common direction and simplicity, or more generally, the law of Prägnanz, have wider significance than simply operating as means of organising visual perception, or producing insight at higher levels of intellectual activity.

In 'reducing', some would say, learning to this 'level' or kind of generality, it might be thought that the only concern here is with learning which is in some way expedient and applicable only to basic or lower order needs, but it is argued that attention and, in particular, the ways in which it is gained and given, i.e. its subsystems,[9] are of prime importance at all levels of learning, whether the hierarchy in question is of Gagnerian[10] origins or more socially oriented:[11] that they actually underlie what Berlyne - in attributing curiosity to instinctive exploratory behaviour - referred to as "epistemic curiosity".[12]

2.2 Awareness of Change

Not only may human beings be described as vulnerable inhabitants of a potentially hostile environment, but as living organisms we are also constantly and inevitably developing and changing. Our mental states are necessarily changed as new experience and information are acquired.

In his definitions of schemata, Ulric Neisser[13] describes how perceiving does not change the world, it changes the perceiver. He argues that the perceiver becomes what he is by virtue of what he perceives.

Neisser implies, however indirectly, that perceiving is learning, and one might add in the context of the present argument that, although the perceiver does not change the world by his act, as one living organism among other living organisms he changes the world by his presence within it. Further, at the risk of venturing tangentially into philosophical arguments well beyond the scope of this paper, the reality of the universe is a changing reality.

It is widely accepted that Homo sapiens has innate needs for feelings of security, permanence and stability (as well as well known needs for stimulation and sometimes even, risk),[14] but the significance of mechanisms of mind described variously by the Gestaltists, Freud, and others, for coping

with often "degenerate and fragmentary"[15] evidence of what is happening in our individual 'worlds' is not generally understood with reference to learning, or even clearly recognised.

In fact our surroundings are constantly in a state of flux. The very light by which we perceive is a changing light, both daily and seasonally, but perhaps more important to us in our vulnerability are less predictable meteorological and longer term geological changes. More commonly, any organism is subject to threat by the presence of other moving beings or objects, but whereas stone-age man might have had to contend with the sudden approach of a sabre-toothed tiger or the odd stray arrow piercing the air, current road accident figures suggest possible situations no less dramatic and equally relevant to the study of attention.

Life is by definition a changing process. No living organism, whether individual or societal, is static, and no environment remains unchanged or unchanging, however slowly. Even concrete forms change by the actions of the elements and/or society on them and one of the most fundamental challenges to any organism must be to recognise change, and patterns of change, and to learn to cope with or adapt to them as they occur: in Piagetian[16] terms, to assimilate and accommodate. As Neisser puts it, again equating perceiving and learning,

> Perception and cognition are usually not just operations in the head, but transactions with the world. These transactions do not merely inform the perceiver, they also transform him.[17]

With only limited control over our individual environments, it is of vital importance that we respond quickly to sudden changes as they occur. We must be constantly vigilant in order to orientate ourselves and minimise threat by swift recognition of cues and signals. Furthermore, as well as the need for vigilance and active exploration of our physical 'worlds' in the short term, in order to function effectively and remain unscathed, it

is necessary for us to gain understanding and insight into many much more complex kinds of interaction: not only must we function within complex social systems, we must interact with the hazards of our man-made, as well as natural surroundings which, in twentieth century terms, include such hazards as the possible malfunctions of nuclear power reactors for instance.

By pursuing ideas of this kind, it is possible to see Piaget's developmental psychology with reference to child learning as an analogy of man's more complex activities and interactions with the world, both in existential and (at macro level) evolutionary terms. Even Zen Buddhism with its central tenet of the need to attend to the moment and respond to change, with reference to spiritual and mental welfare, is not inappropriate here.

Because of our vulnerability we are vigilant. We exercise our vigilance through our senses. We cannot, however, attend to all our senses at once, nor can we register and assimilate all available signals. Some kinds of signal we attend to consistently more readily than others. Our attention is selective, and our 'normal' state is one of responsiveness to change.

Prolonged attention or concentration is not a natural condition. It is accepted for example that for most efficient teaching and learning, pauses or changes of activity aid concentration; and the need to ingest stimulants in the form of caffeine or nicotine when unusual efforts of concentration are demanded is well known.

The belief that our natural or ideal condition is one of changing attention, or distractability, concurs with the Functionalist[18] position and, in particular, with that of Woodworth[19] and his concept of 'situation-set', in which he refers to adjustment to environmental objects and the fact that the environment must be brought into psychological account in a manner not suggested by traditional stimulus-response theorists,[20] whose

concern is more with focus (on a particular signal) than scanning.

The fact that we are 'tuned' to react to a constantly changing environment is also borne out by more recent research into sensory deprivation,[21] in which subjects have been found to hallucinate and suffer other distressing symptoms, presumably as a result of concomitant disorientation and uncertainty about changes which might be taking place around them. However, whereas functionalist psychology can be seen as one important application of Charles Darwin's concept of adaptation, the fact that we attend most closely to specific kinds of environmental change has much wider implications for education (as will be discussed later) than already recognised by John Dewey[22] for instance, in his early emphasis on the importance of appealing to the learner's own interests.

2.3 Attention Devices

Dennis Child's[23] summary of factors which influence attention in learning, with its emphasis on 'change' and 'intensity of stimuli', incidentally also neatly summarises key signals of environmental threat which provoke arousal in many living organisms. This coincidence lends support to the idea being developed: that the senses and affect are of much greater importance in learning than generally recognised.

Factors in the environment likely to attract attention as listed by Child are:

intensity of stimuli
novel stimuli
variable and changing stimuli
certain colours
conditioned and habitual stimuli

The attention value of certain colours (particularly red) and sounds (particularly high pitched sounds) are well recognised and commonly utilised in the arts and not only in fine art, music and drama. They are much exploited in the graphic arts, in commerce and in industry, along with all

of the other factors listed. And of course in the absence of physical threat, the next best way of attracting attention, equally primitive and pertinent to the argument, is by reference to sex. The fashion industry, in common with many others, exploits both kinds of attention stimuli: those relevant to the vulnerability of the individual and those relevant to the procreation of the species.

Most interestingly, in the case of the fashion and allied industries, stimuli associated with arousal promoted by potential threat in the environment and stimuli incorporating sexual interest are used together to exploit the sex drive itself (which, in circumstances not too difficult to imagine, must be of secondary interest to individual survival), in order to service a market. Whereas we may be aware that an advertiser is making appeal to usually guaranteed interest in sex - necessarily a highly conscious aspect of behaviour, being dependent for its effectiveness on awareness of sensual pleasure - mechanisms of mind which operate to cope with threat and anxiety do so by allowing us to be conscious of only as much as we can cope with safely, i.e. without undue psychological stress. The survival instinct is just as much a concern of the senses as sex, but in a rather more subtle manner: a notion to be explored in connection with perception and memory.

All of the factors involved in attention cited by Child correspond very closely with a summary in Meldman's discussion of what he calls the "mental subsystems of attention".[24] He also comments that situations containing a high degree of novelty, suddenness and surprisingness result in responses similar to those elicited by emergency situations.

Meldman quotes many definitions of attention, all of which are relevant to the APM-A perspective being developed. However, four of them are especially significant:

> Attention involves the selective awareness of certain sensory messages ... (Hernández Péon et al. 1956b)

> Attention is a preparatory stage in perception or exploration. (Woodworth 1950)
>
> Attention is a selective function which enhances awareness of something in particular. (Oswald 1962)
>
> Only the most important signals coming in will be acted upon and remembered. (Deutsch 1963) [25]

The fact that others may say that selection is a function of perception or memory, or that perception precedes attention,[26] is not material to the point being made here which is that, even in connection with the attentional aspect only of APM-A, the definitions above all hint at the inextricability of its other aspects. Perception, memory and arousal are all suggested by phrases such as "preparatory stage", "selection of certain sensory messages", "enhancing awareness" and of course in Deutsch's suggestion, with reference to attention, that "only the most important" messages will be "acted upon and remembered". Relevant too is the notion of attention as memory or learning. Craik and Lockhart in fact talk of "perceptual processing"[27] in memory.

Meldman also quotes Deutsch's theoretical position[28] on selectivity of incoming messages. Deutsch postulates that the level of general arousal[29] within the organism will be increased, and increased for varying lengths of time in proportion to the importance of the message, e.g. messages which would not normally be heeded will command attention if they follow in the wake of more significant information. On the other hand more important signals than present at an immediately preceding time will break in.

Deutsch also notes that awareness and behavioural responsiveness to peripheral stimuli are absent without arousal, and that some degree of general arousal is necessary for selective attention to operate. With specific reference to arousal she points out that individuals will attend to any incoming message, provided that it is not concomitant with a more important one, whereas when asleep only very important messages such as

one's own name will be attended to, or in the case of a mother, the sound of her infant crying. When drowsy, though responsive to a larger range of stimuli than when asleep, subjects tend to miss signals which would be noticed when fully awake - which of course might be expected if an individual's need for sleep is more important that the signal, and sleep is regarded simply as the raising of conscious threshold.

The concept of arousal is closely linked to that of expectancy, and in turn, arousal and expectancy are intimately involved in learning.

2.4 Expectancy

Any degree of expectancy which may be described as 'anticipatory' attention, rather than heightened awareness or general arousal which might be stimulated by the kind of environmental events already described, involves learning. Learning is, after all, an association between the present state of affairs and one that has followed that state of affairs, or similar, in the past.[30]

Within the APM-A construct it is suggested that even heightened awareness and general arousal which occur as a result of the kind of stimuli described by both Child and Meldman (in very different contexts) are anticipatory and result from a kind of learning: a kind which may helpfully be described as species learning. Both Latane and Hothersall[31] on social attraction in animals, and Konrad Lorenz,[32] refer to innate factors produced through phylogenic adaptation governing behaviour, and claim that certain animals possess what Latané and Hothersall refer to as Innate Releasing Mechanisms (IRM): thus specific cues or key stimuli have the innate capacity to unlock, or trigger, Fixed Action Patterns (FAP). The latter are intuitive response sequences which occur in virtually identical fashion in all members of the same species. Lorenz quotes the example of the female tick which responds specifically to butyric acid, a product of the mammalian skin glands. The tick may climb to the tip of a bush and

stay there for months sometimes, until this one stimulus promotes her to drop on to the mammal below.

Highly relevant to the APM-A view of the importance of instinct (species learning) and the senses in individual learning, Lorenz says,

> To understand individual learning you must begin with the fact that we and the rest of the animal creation start our lives with a substantial store of innate information that can be amplified by the right experience. Much of the innate information takes a simple plus or minus form, telling us, This feels good, that feels bad - do this again, don't do that again.[33]

Anticipatory arousal reflects the individual's uncertainty about the nature of the situation, whether involving expectancy (in the accepted 'learned' sense) or not; and even without the degree of control afforded by specific expectations, a moderately aroused state permits speedier and more effective action as a result of both heightened sensitivity of exteroceptor organs and the experience of less strain than having to cope with sudden mobilisation. As Meldman[34] points out though, excessively intense anticipatory arousal which spirals out of control can give rise to a state of general foreboding, apprehension and dread.

The fact that attention and learning are more effective when opportunity arises for some degree of anticipation to help focus attention on appropriate signals is borne out by research into memory. Sylvia Sherwood,[35] investigating gerontological problems of learning and memory, found evidence that reduction in speed of reaction in learning is not as marked when experiments involve familiar or repetitive situations which allow the subject to anticipate the stimuli (in other words - when there is appropriate set or expectancy).

Hunter[36] uses the example of the difference in speed of response and recognition, between waiting for the telephone to ring, rather than not expecting a call when it may take some moments to identify a ringing, as

an example of how expectancy facilitates recognition; whereas Meldman[37] discusses expectancy as serving as preparation by contributing to the efficiency of filtering and signal detection. He remarks that forewarned is forearmed.

2.5 The Senses in Learning

There are many examples in experimental studies of memory which signify the importance of the senses in learning. Both Sperling[38] and Agruso[39] view memory as involving three stages of which the first is a sensory stage. In Agruso's case the second stage is also a sensory stage, acting as sensory storage and involving engram and sensory trace, whereas for Sperling the first stage constitutes a complete trace of stimuli as iconic memory.

Other investigators suggest that it is the sound of a word that is stored in short term memory; and echoic memory, as the auditory equivalent of iconic memory is well illustrated in experimental studies involving dichotic listening tests.[40]

Craik and Lockhart, in their dismissal of a multi-storage or box approach to memory, suggest a continuum from sensory traces or sensory interpretation of signals to more meaningful associations and relevance, so that in their concept of depth processing, strength of trace corresponds to the level of processing that the information undergoes. This implies that items receiving full attention and analysis, or which have relevance to existing experience and knowledge, lead to relatively permanent traces. Within this context the importance of the senses and what happens to information at sensory level in memory and learning is vital. Even more interesting is the role accorded attention within this particular concept of memory - that items receiving full attention lead to fairly permanent traces.

This view of memory as a continuum from sensory to long term and including the concept of attention, coincides perfectly with the view of

attention, affect and learning which unfolds from the foregoing discussion: that learning derives from the function of a deeply instinctive mechanism which is still vigilant for potential threat to the organism above all else. It is seen to operate in such a way that not only is attention still gained by lower priority environmental events if actual threat does not materialise but, in the idiom of Marshall McLuhan,[41] the medium and not the message may command full attention. As is well recognised in the advertising industry, and postulated by Deutsch (2.3), as the level of general arousal in the organism is increased less 'important' messages following in the wake of a priority signal are also likely to be heeded more than content would normally justify. Therefore a priority signal (see note 17, chapter 1) may have instrinsic affective value and be remembered as a significant event in its own right, or it may have what could be called cue value and for ever more be associated with something else - possibly as mundane as soap powder or deodorant, or some other well-advertised but thoroughly banal product.

By contrast, sensory deprivation experiments discussed earlier (2.2) suggest that in extreme circumstances, in the absence of even low priority signals, panic may ensue, as the individual is left with no feedback from the physical or social environment and therefore no means of orientation or checking on levels of security. In quite different circumstances, security may seem to be threatened when a novel stimulus of sufficient intensity impinges on a receptor to evoke a strong response, but if the stimulus is repeated in slow monotonous series, this response diminishes.[42]

Hilgard and Bower in their explication of the neurophysiology of learning[43] consider the various phenomena of habituation, selective attention and distraction (with reference to experiments by Hernández Péon on the effects of novel stimuli) and refer to "sensory gating", their term for the modulative influence all along the sensory pathways of a particular

receptor to primary receiving areas of the cortex. However, the term 'gating' is seen to be rather misleading in this context as it carries an inherent suggestion of the possibility of other processes coming into play at stages along neural pathways, rather than the idea contained in the term 'filter'[44] for instance. But although the latter is more consistent with the view being presented, ie. of habituation as a continuous diminishing of interest (ie. diminishing activity of a single process) in a signal which steadily becomes part of the environment, in contrast to it having originally commanded attention by arriving as a harsh intrusion, the term 'filter' is still inadequate.

Although the notion of 'filtering' is rather more appropriate to the perspective being offered than 'gating' it still carries only a narrow description of how attention is limited. The point has already been made (2.2) that living organisms are 'tuned to change' and always need some degree of sensory stimulation.[45] This suggests that our reactions to our surroundings are not simply of a negative kind and centred on keeping unwanted signals out, but that human organisms (in common with other higher mammals and primates), in the absence of high or low priority signals, actively seek sensory information, ie. stimulation. Therefore the quest for the 'filter', which has absorbed many researchers and theorists, is not being regarded as a fruitful area of enquiry within the APM-A perspective. Rather, the firing of neural cells or not, and to what effect, is seen to be dependent on whether interest is sufficiently highly aroused and/or maintained.

It seems reasonable to assume that neurons continue to fire - with greater or lesser intensity - as long as the cortex continues to 'work' on information being processed, either in terms of making simple associations or much more complex kinds of identification and classification.

APM-A implies that the amount of neural cortical feedback (or electro-

chemical activity in neural pathways and brain), following change in the environment, relates directly to the stimulation value of a signal and the degree of interest it arouses in the individual. This, in turn, is seen to relate to whether it is remembered or not and, if so, for how long.

2.6 Emotion and Arousal

Having discussed memory, perception of priority signals and attention as related to each other, existing on continua and subject to the notion of depth, it is a relatively simple matter to delineate emotion in similar terms.

Emotion is in fact traditionally described according to intensity, and language is rich in appropriate metaphor. Spatial metaphor is most common. We can feel high or low. Our feelings can be light or of deep gloom - worse - we can plumb the depths of emotion. Although in chapter 3 it will be argued that emotion manifests itself as changes in both physical and mental states, concern for the moment is with degree of disturbance rather than kind, and with a simple high —— low dimension consistent with the continua already suggested.

Although emotion is most often identified in connection with personality or motivational factors in the learning process, it is rarely recognised for what it is in the areas in which its intervention is most critical, viz. in attention and perception (and therefore within the perspective offered here, memory also). Emotional reactions in learning are most often interpreted as the result of intellectual problems - usually as lack of concentration - rarely as the cause. Even difficulties in communication, interpretation or observation rooted in perceptual problems are seldom recognised as such by the teacher.

Meldman, referring to the "emotional subsystems of attention",[46] quotes Bleuler. For Bleuler affectivity is an essential aspect of attention to the extent that where affectivity is lacking, the drive to follow

"internal processes" and to direct one's senses and thoughts is also deficient, so that active attention is impaired. Bleuler sees emotion as coterminous with drives and as a source of focus. He says,

> Affectivity, which is one with instinct and impulses, determines the direction of our endeavours.[47]

Rado,[48] also quoted by Meldman, sees emotion not just as a central mechanism for arousal, but as arousal, whereas Lindsley[49] suggests that emotional states are states of high arousal. The same overview includes mention of the fact that in Freud's psychodynamic theory, attention is considered to be a special function instituted to periodically search the outer world in order that data might be already familiar should urgent need arise.[50]

In the light of experimental findings and a Darwinian perspective, however, two amendments can be made. First, scanning is not periodic but continuous, in that our senses are always receptive to some stimuli. For evidence, one need only consider phenomena already mentioned, such as latent learning or the 'cocktail party effect',[51] or consult the writings of Desmond Morris,[52] who has been more successful than any perhaps in describing unconscious perception and its effects on behaviour. Secondly, although Freud was responsible for identifying unconscious motivation he doesn't identify the crucial relationship between individual motivation and retention. However, it is to Freud that we owe the notion of defence mechanisms,[53] without which, the important concept of perceptual defence may still not have been recognised as the emotional response it is.

2.7 Perception and Emotion

Homo sapiens must cope with all kinds of potential threat within the total environment, from the banal and every day twentieth century possibi--ities of cutting self whilst shaving or stepping in front of a bus, to perhaps a disastrous misinterpretation of a political situation at statesman

level: worse still, the evidence available to us via our senses is more unreliable than we think.

Ironically, the very mechanisms which appear to exist in order to enhance feelings of security and facilitate appropriate responses can be dysfunctional: an indication that learning in its broadest sense, as development of persons, should be as rich as possible, so that we come to be able to recognise the limitations of our perceptions, and be fully aware of possible alternative interpretations of any given situation, rather than accepting as necessarily valid the one that is immediately (or habitually) perceived, or seen as 'common sense' (with its well known paradigmatic limitations). In the language of the visual arts, it is possible to learn to recognise the negative as well as positive shapes, figure and ground, i.e. be able to see beyond the 'good Gestalt' and recognise phenomena for what they 'are', or at the very least keep an open mind and resist the tendency to classify a perceptual event as part of the already known, when evidence is fragmentary.

Defence mechanisms of the kind identified by Freud are discussed by Vernon in the context of a large number of experiments designed to investigate the effects on perception of material likely to produce emotional conflict in the observer. For instance, in experiments measuring the reaction times of subjects to lists of words, including some with sexual connotations and tabooed in normal conversation, it has been established that whereas some subjects consistently perceive tabooed words most quickly, others consistently perceive the same words more slowly. The one group are said to exhibit perceptual facilitation, the others, perceptual defence. Even more obviously relevant to the APM-A perspective, the amount of effect on perception time has been found to be related to the degree of emotional threat perceived in the experimental material. A decrease in reaction time occurred in relatively 'well adjusted' observers, and an increase in the

'less well adjusted'.[54]

Similar effects have also been found in a poisoned food study[55] with elderly subjects who did very poorly on concept formation tests when stimulus categories were colour, form and number, but when the task changed to identifying poisoned food, and the information provided about various foods included whether individuals 'lived' or 'died', performance scores increased significantly.

Vernon concludes that relevant motivation (or significance of task), and pleasurable emotion can facilitate perception. On the other hand, experiments in which unpleasant emotions have been aroused by some form of painful experience, by frustration of needs or desires, or by arousal of emotional conflict over sexual feelings, experimental tasks have been mostly disrupted, being performed more slowly and inaccurately. In fact, both kinds of findings accord with the Yerkes - Dodson[56] arousal curve which demonstrates findings that moderate arousal has a beneficial effect on performance, but excessive arousal leads to inefficiency.

In the Freudian psychoanalytic context unconscious blocking of recall of unpleasant or traumatic experience results in amnesia, which serves as an example of defence operating at a much deeper level of processing than that described above. And as well as the identification of repression in the elaborate theories of Freud, in which it is illustrated as a defence mechanism, and his well-known descriptions of hysterical, theatrical and other kinds of self-deluding behaviour, other, psychosomatic, 'strategies' manifested as for example nausea and/or headaches are known to be adopted to thwart even deliberate attempts at recall.[57]

The point of this very brief excursion into psychodynamic theory is to introduce the idea of Gestalt psychology and, specifically, the Law of Prägnanz as describing a similar kind of coping mechanism - a defence mechanism which 'makes sense' (tolerable sense) of environmental data as rapidly as possible - and to stand phenomena identified by the Gestaltists,

along with the other aspects of attention, perception, memory and arousal under discussion, within the context of information processing.

All that has been said so far has been to suggest that as beings already only too aware of our own vulnerability, our innate need for security is far greater than generally acknowledged, so that at sub-threshold levels of consciousness we process all signals in terms of potential threat and procreative value first, and only then in terms of how "useful to our purpose" in Oatley's terms, the information might be.

2.8 The Senses, Perception and Understanding

The way in which we interpret and understand sensory experience is the way in which we interpret and understand the world. Even successful interpretation of the written word and language is dependent on the efficient functioning of the sense receptors, and subsequent decoding by the cortex. An apparently obvious fact, but the crucial importance of sensory acuity has been surprisingly neglected by some researchers. This is true both of the field of memory research, where the tendency has been to extrapolate from results of experiments in short term memory and apply them to long term memory,[58] and of research into ageing and learning where the tendency has also been to confuse decrement in sensory acuity with decrement in memory of any kind.[59]

It takes very little reflection to realise that we think in the language of our senses: we think in images, sounds and tactile experience. We use models, i.e. theoretical constructs, to help order our thinking. We can even think textures or imagine sweet and sour tastes, and a vivid description of the Thames say, before the efforts of Brunel, could soon evoke feelings of nausea.

We know that adults continue to acquire vocabulary. It is possible that continuing to gain experience of, for example, form, shape, mass,

texture and colour and even increasing perceptual experience of the same concepts in sound - as certainly the terms colour, texture, shape, tone and pattern transfer very easily to music - may be of significance in the continued development of conceptualisation, of being able to manipulate and use ideas. It has already been mentioned that we use spatial terms to describe our emotional states (2.6). We talk of feeling high or low and we speak of 'looking forward'. The phrase 'looking forward' is also one of the many examples of use of visual language to describe thinking, e.g. to see a point of view, to adopt a particular perspective, or consider another aspect, to look at the other side of a question, colour an argument, follow a line of thought or have insight. We even transfer auditory and tactile experience to the description of visual stimuli, e.g. a quiet pattern. There are also many phrases one could quote with reference to the senses of smell and touch used in description. Are not all adjectives derived from sensory experience?

We can go on adding to our store of experience of the world and the greater the store of experience we develop, the richer the repertoire of conceptual possibilities we build.

Experiments conducted with children in enriched and deprived environments have clearly indicated a correlation between high I.Q. and a high degree of stimulation in the environment. And although such experiments are not conducted with direct reference to the importance of the senses in learning, but usually to research the effect of socio-economic factors on intelligence, what is stimulation if not auditory, visual or otherwise sensory? Even 'intellectual stimulation' can be gained no other way. Without sight the blind man depends on touch, both to read and to build up his own store of 'imagery'.

The Law of Prägnanz helps to make sense (a particularly interesting phrase in this context) of ever changing sensory stimuli and thereby helps

to reduce uncertainty. Whereas changing light and shadow on a wall can be rapidly understood and attributed to a source by an adult, a small child with less sensory and intellectual experience may easily be frightened.

But it is not only our visual experience which develops to a point at which we think we can explain almost anything. We are constantly building up information about other people, for instance, and all of this information has to be encoded and made 'sense' of too.

Well known psychological phenomena described in detail by Argyle[60] and understood as attribution, categorizing and stereotyping, are all means we adopt to make sense of and feel secure in our relationships with others: a vital and unavoidable element of our daily interactions with the world.

To propose that Gestalt psychology may be applied to other kinds of perception than visual or aural might seem to be an invalid generalisation (even though our perceptions of other people are mainly visual and aural). But in whatever way we might describe phenomena such as categorising and stereotyping, they certainly appear to serve the same function as the 'good Gestalt'.

Perhaps a term other than Gestalt might be used. Anschein (appearance) might not be bad, except for its strong visual overtones, so perhaps a more neutral term like Verstand (understanding) would be better. It is a term which is equally appropriate to any of the senses, and implies a relationship with experience and learning.

2.9 The Attention Mechanism

Much debate about attention centres on the existence or not of an attention mechanism; on what kind of mechanism it is and where it is located. Since Broadbent[61] it has been identified most often as a filter, but that supposition has already been rejected within this perspective (2.5).

The conclusion being drawn from all that has been said so far is that,

difficulty in locating such a mechanism derives from its extremely complex and dynamic nature. Instead of being a filter model, the APM-A model is a selection model; a highly adaptive and interactive feedback model of attention dependent on certain prime 'purposes' of the organism. The need for fulfilment of both species and individual purposes indicates interaction between biogenic and sociogenic influences on attention and, as has already been stressed, the complexity of the process is compounded by the interaction of attention with perception, memory and arousal.

The APM-A model therefore identifies and subsumes major aspects of learning which may be put under the following headings:

development of purpose dependent on affect

- adaptation as
  - i) species adaptation which accounts for identification of priority signals which relate directly to prime purposes - avoidance of danger and procreation
  - ii) individual adaptation, accounting for sociogenic influences on the development of personality, intelligence and the development of individual purposes.
- motivation as a complex, dynamic and phenomenological interaction of biogenic and sociogenic purposes
- feedback as neural - cortical activity, i.e. feedback between interoceptors and brain, and exteroceptors (senses) and brain, on which continued interest, and subsequent response to any given signal depends.

In chapter 3 the cognitive and affective aspects of motivation (purpose) will be more closely defined as particular functions of the evolutionary development of the brain. However, the whole APM-A construct can be more closely identified in terms of its major dimensions:

2.91 internal ——— external

The attention mechanism is being viewed as a defence mechanism which monitors change, changes within the environment and changes within the organism; changes which govern action, e.g. avoidance of danger, search

for food or cover, search for a mate (or simple utilisation of sexual opportunity), or the assimilation of 'useful' information for some more complex or idiosyncratic purpose.

As a deeply instinctive and highly interactive mechanism involving autonomic (ANS) and central (CNS) nervous systems, the attention mechanism is not a neat mechanism located as an isolable piece of machinery at a specific site within the organism, but a multi-dimensional process.

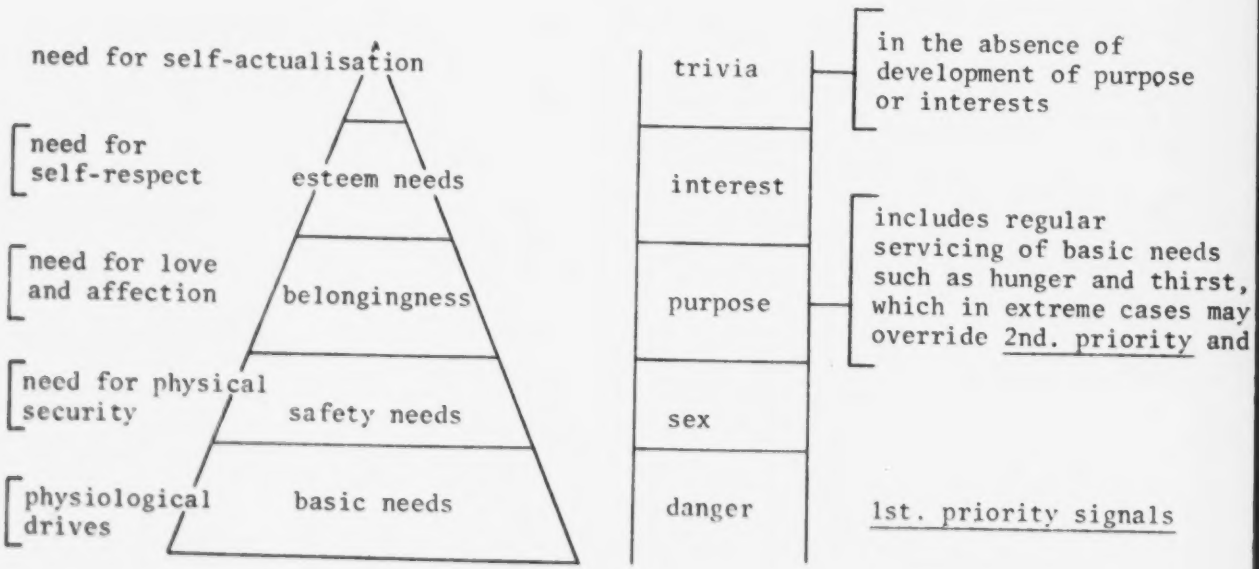
It has been argued (2.2) that man is 'tuned' primarily to cope with change, which he does by means of the kind of neural-cortical feedback described above (2.5), therefore a model of attention must account for continuous neural activity, i.e. exteroceptor ⟷ brain, interoceptor ⟷ brain feedback. A simple one way joining of mind to sensations (as in a filter model), or a simple selection model which accounts for one way processing only, is seen to be inadequate.

2.92 given ——— gained

As a result of species adaptation certain environmental events will gain attention even as unwelcome distraction. It has also been argued that in the absence of, first, signals indicating potential threat and secondly, signals implying procreative opportunity or - a distinction which has to be made in twentieth century western culture - more usually sexual encounter in which procreation is actively avoided, attention will shift to other messages offering any hint of either, i.e. to signals described earlier (2.5) as having 'cue value'; and only in the absence of all such signals will it be given to lower priority stimuli to do with the particular, current purpose of the person. Further, if only very low priority or even quite inconsequential environmental information is available, attention will be absorbed with this. In very rare circumstances when no feedback or sensory stimuli are available to the organism to "update neural maps of the external world", [62] panic is likely.

It becomes possible therefore to construct a hierarchy - of diminishing interest - in which attention capacity continues to be used, but shifts down the priority scale to whatever stimulation happens to be available.

Whereas Maslow's hierarchy of needs implies that new needs are attended to only after basic and safety needs (his order)[63] are satisfied, and that interest will then ascend to higher order needs, within the APM-A hierarchy attention would ascend in terms of altruism only providing the individual had been fortunate enough to acquire the "symbolic goods"[64] necessary for its expression; but in the absence of developed purpose, or interests even, attention will be given or gained by stimuli of a quite trivial nature:



(Maslow's hierarchy of needs)

The APM-A hierarchy of attention, in which 1st, 2nd and 3rd priority signals not only have 'affective value', but may cause signals immediately following to be given more attention than they would normally merit, i.e. have 'cue value' (2.5)

Figure 3 Maslow's hierarchy of needs compared with the APM-A hierarchy of attention as a hierarchy of diminishing interest, in which capacity of attention remains unchanged, and in which 1st and 2nd priority signals relate directly to the survival of the individual and survival of the species respectively. The APM-A hierarchy of attention is not offered as an equivalent to a hierarchy of needs. The relationship between the two is explained and an alternative hierarchy of needs defined in Gear, J, Perception and the Evolution of Style: a new model of man, Routledge and Kegan Paul, London (in press).

Obviously signals associated with needs identified by Maslow command attention, but it is being argued that because of the phenomenological nature of attention, interaction takes place between conscious attention given to needs and sub-threshold scanning of quite unrelated information.

For instance, group or ego needs could coincide with purpose or interest, but whilst involved in a group activity say, a signal related to a career opportunity could temporarily command full attention, which in turn could be overridden if the barman shouted "Fire!".

2.93 conscious ——— unconscious

Norman,[65] after reviewing theories and research into attention, concludes from analysis of theories of 'early' and 'late' selection of information, that it is necessary to acknowledge both 'top-down' (associated with late selection) and 'bottom-up' (early selection) processing of environmental events. Top-down processing is understood as conceptually driven analysis and classification of stimuli, and bottom-up as a data driven means of processing information. He suggests that both take place simultaneously, and by reference to the APM-A model it is possible to offer an explanation of their functions.

By regarding top-down processing as comparable to that identified by the Gestaltists as conforming to the Law of Prägnanz, and dependent on proximity, similarity, common direction and simplicity, it is possible to interpret this phenomenon as the result of a need to reduce ambiguity. According to this view, in the short term, top-down processing facilitates rapid and decisive interpretation of a novel or ambiguous signal and, in the long term, a signal may be subjected to further unconscious scanning in case of possible relevance to some long-standing puzzle. On the other hand, bottom-up, or data-driven processing may be regarded as having less concern with reduction of uncertainty than with organised storage of

useful information which relates to the already consciously recognised and known - to currently used knowledge and current level of experience or, in Watson's[66] terminology, to frequently or recently used information.

Both kinds of reaction to stimuli operate by making links and associations, noted throughout the history of thinking as being characterstic of the way the mind 'works'. But whereas bottom-up or data-driven processing refers to the steady strengthening and increasing of specific, known and conscious links (typical of those described by Behaviorist psychologists), top-down or conceptually driven processing operates by finding much broader and more general associations from a much larger, long-term store of associations. This conceptually driven processing may well go on long after the signal occurs, for days, weeks, or sometimes on and off for years as further related signals (sometimes quite obscurely related signals) are filed with the others, until suddenly a flash of insight intrudes into consciousness - often at a very inconvenient moment - to solve a long term uncertainty or problem.

Data driven processing could therefore be said to refer primarily to the present, to routinised skills and to consciously known facts before they become part of some possibly complex and difficult to define concept; equally, conceptually driven processing could be said to operate with reference to the past and future, offering deeper and broader understanding and enabling longer term planning, by reference to sometimes only very subtle hints or intuitions of a possible outcome, or as a result of the well known phenomena of insight, inspiration or 'brainwave'.

In a recent paper, Shiffrin and Schneider[67] offer experimental findings which identify 'controlled' and 'automatic' information processing following an earlier advocation of a fundamental division of human memory and information processing into (i) labile control processes and (ii) learned or inherent structural components. Their findings are also entirely consistent

with the interpretation of the two levels of processing identified above and, interestingly, they describe the benefits of a system based on the two basic processing modes as follows: (a) It allows the organism to make efficient use of a limited capacity processing system. The development of automatic processing allows the limited capacity system to be cleared and devoted to other types of processing necessary for new tasks. (b) It allows attention to be directed (through automatic attention responses) to important stimulation, whatever the nature of the ongoing controlled processing. (c) It allows the organism to adjust to changes in the environment which make previously learned activities useless or harmful. (d) It allows the organism to deal with novel situations for which automatic sequences have not previously been learned. (e) It allows the organism to learn increasingly complex modes of processing by building upon automatically learned subsystems. (The underlining has been added by the present author).

2.94 scanning ——— focus

Within the APM-A view scanning takes place immediately prior to top-down and bottom-up processing (i.e. immediately below threshold) as a constant vigilance exercise alert for vital signals or, in their absence, for lower priority, less vital but interesting events worthy of conscious - or unconscious - focus. Scanning also takes place consciously, both as conscious vigilance or searching of the external world and as internal 'searching'; perhaps to find the right word, to remember a name, or in order to solve a 'tip of the tongue' problem which can sometimes lead to 'immediate' focus in the form of a solution but more often, and frustratingly, the solution 'occurs' later when the moment has passed. This phenomenon suggests that unconscious processes took over as conscious attention was required elsewhere - and that it was gained as a result of sub-threshold

scanning picking up a (phenomenologically) more important signal. Scanning and focus take place consciously as the result of knowing, however vaguely, that we have encountered a signal, or one related to it, at least once before, whereas our knowledge of unconscious scanning and focus is by inference only, often as the later realisation that a false interpretation of an ambiguous situation may have taken place, as a more likely alternative 'springs to mind', or as the kind of flash of insight at an unlikely moment already described.

To conclude: APM-A ——→ Verstand refers to learning as a highly interactive and complex process of acquiring information, which is of use to the individual both in terms of existential purpose (in response to phenomenological internal and external changes), as well as in longer term plans and purposes. In extreme circumstances, total attention capacity may be absorbed in the fulfilment of survival needs, but the view of man suggested by the APM-A construct is an essentially humanistic view: that is, a view of a responsible being who, although susceptible to own mechanisms of mind which relate to basic survival needs and adjustment to change, has life-long learning capacity. This enables the perception of alternative and possibly more subtle interpretations of everyday, or crucially important, situations than those which an immediate 'classification' might suggest, and allows the consideration of needs beyond those of self, and the present, only. This complex capacity to learn enables experience to be drawn on, not only directly but also indirectly, by proxy, through the knowledge and insights of others (2.1). The view of man presented is of an active being, not simply filtering out unwanted sensory data but being absorbed by whatever is perceived to be most important to the individual, particular group, or society - at the time - and having the ability to draw on past experience, and past history, in order to perform more effectively in the present, and plan for the future.

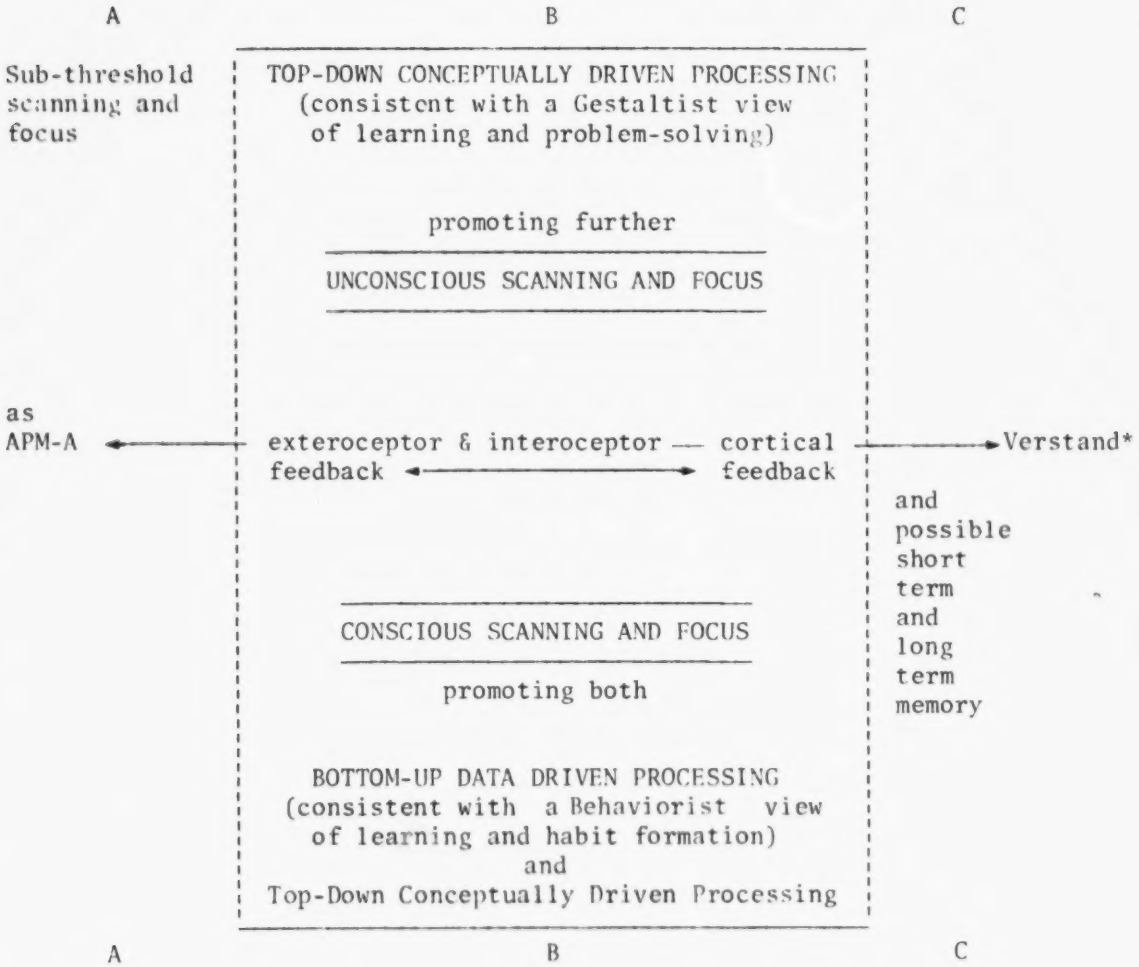


Figure 4 APM-A ——→ Verstand: a model adopted to describe identifiably different, but simultaneous, kinds of information processing as a phenomenological and a long term, dynamic process.

A Attention, perception, memory and arousal interacting as sub-threshold scanning and focus to produce possible registration of stimuli and further processing.

B Attention, perception, memory and arousal maintained during further conscious and unconscious scanning and focus (resulting in conscious and unconscious classification), and possible addition of data to long term store.

C Understanding and memory ranging from the readily available and consciously known to a long term store at unconscious level, as a result of sustained conscious or unconscious effort.

* German (understanding): a term used here to imply all that the term Gestalt implies, but with an added long term and mutable dimension.

In this chapter analysis of phenomena associated with attention, perception, memory and arousal has been drawn on and offered in support of the concept of APM-A as a complex and highly interactive process. It has also been argued that as manifestations of the APM-A process, attention, affect and learning are similarly interactive and interdependent (as are emotion and cognition: see pp 47-48). The entire construct has been labelled APM-A ——————►Verstand (Figure 4) and describes sub-threshold (of consciousness), conscious and unconscious levels of processing (Figures 2 and 4), in terms of two-way feedback between exteroceptors (senses) and brain, and interoceptors and brain, leading to short term and possible long term registration.

The role of the senses has been emphasised, and essential to the whole construct is the notion of a hierarchy of signal values, developed as a hierarchy of diminishing interest (Figure 3), which defines kinds of signal (i.e. sensory experience) most likely to evoke an emotional response, i.e. activate the APM-A process, short term registration and, depending on degree of affect, effort to understand and the possibility of long term retention and availability.

3 ATTENTION AND MOTIVATION

3.1 An Unavoidable Concept

It would be unreasonable to identify certain concepts as crucial to the understanding of learning, and therefore to any learning theory, without accounting for the fact that most major learning theorists have apparently managed without any reference to attention, perception, arousal or affect at all. Even direct reference to memory is unusual, although most theorists do adopt a position on forgetting, albeit often under such guises as 'experimental extinction'[1] or 'retroactive interference'.[2]

Clearly, to detail all oblique references made to attention and arousal by all of the major theorists would require a paper to itself. However, it is hoped that by giving examples of how some theorists, belonging to different psychological schools, have dealt with what is seen here to be an unavoidable concept of learning, and by offering tools of analysis which can be applied to other theories, a convincing case can be made in support of the proposition that however strenuously avoided, the concept of attention and its intimately, or more accurately, inextricably, related concepts have to be dealt with.

Hilgard and Bower,[3] in discussing issues on which learning theorists divide, identify "three kinds of preference" on which stimulus - response theorists tend to differ from cognitive theorists. First, Hilgard and Bower identify a preference for "peripheral" versus "central" intermediaries, by which they differentiate between the "chained muscular responses" favoured by S-R theorists on the one hand, and emphasis on central brain processes preferred by cognitive theorists on the other. Secondly, they suggest that the stimulus - response theorist considers what is learnt to be habits whereas the cognitive theorist refers to cognitive structures. Thirdly, the stimulus - response psychologist views the learner as achieving successful outcomes by trial and error, whilst the cognitive psychologist

prefers to think that the subject will gain understanding and insight into essential relationships involved in solving a problem.

The analysis Hilgard and Bower make is in fact quite consistent with the relationships between S-R learning and bottom-up processing and a Gestalt definition of learning and top-down processing offered in chapter 2 but, by using the APM-A construct, it is possible to add further valid general statements about major schools of learning theory, and to highlight which aspects of consciousness are taken for granted by particular theorists and which are actively avoided.

In addition to the differences already identified (2.93) in the APM-A explanation of the functions of top-down and bottom-up processing (which would, incidentally, be equally applicable to the kinds of learning identified by cognitive theorists and stimulus - response theorists respectively), it is possible to state that both schools acknowledge learning as having an adaptive function, and both deal with affect, but in quite different ways and usually unintentionally - but unavoidably.

As already implied (2.93), stimulus - response learning, otherwise referred to as the kind of processing identified by Norman[4] as data-driven or bottom-up processing, could be said to refer primarily to coping with immediate demands made upon the organism and with mainly consciously recognised needs: to developing routinised skills and organising information before it is conceptualised. In other words, fulfilling mainly conscious needs to unconscious effect, thereby not only economising on limited capacity of attention by building up routinised skills and organising effort and knowledge, but also constantly adapting the individual's behaviour to the situation in which he currently finds himself - to use Watson's terminology again - to frequent and recent happenings.

It has already been said in chapter 2 that top-down processing which corresponds to a cognitive view of learning, as well as reducing ambiguity by rapid classification of sensory data, may also be interpreted as

functioning with reference to the past and future, with the benefit of the possible solution of long term problems of individuals and societies and with outcomes sometimes so apparently remote from conscious activity and experience as to appear as intuition or inspiration. This kind of learning also serves an adaptive function, but in response to much more complex exigencies than bottom-up processing, it enables the individual, or group of individuals (an important possibility), to work on broader associations of ideas and to draw on less obviously related skills and information in order to plan for possibly quite complicated outcomes of action. So that whereas bottom-up processing can be seen to refer to mainly conscious needs, to mainly unconscious effect, top-down processing can be seen to fulfil often unconscious needs, to conscious effect. The one set of needs, or motives arising from them, consciously focuses attention; the other directs attention as the result of initially unconscious decision making.

Possible motives for unconscious decision making are many and varied. Most obviously, an individual has a need to feel secure within his social structure and may therefore also need to repress antisocial urges if he is not to promote aggression from others. Further, with a need to feel secure within his own set of beliefs and perceptions of the world, he may entertain quite unreasonable and totally unacknowledged prejudices against individuals or situations not understood by him, or which don't fit comfortably within his belief system, but which nevertheless serve to direct his thoughts and actions.

Scope for interpretation of the motivation which results in any particular act is extremely wide, not only because different societies view so many motives as unacceptable, thereby causing them to be repressed, but also because theorists have placed so many possibilities before us. Whereas a Freudian interpretation of almost any act could be that it was performed only as a means of sublimation of another, less socially acceptable desire,

Lewin or Freud might view it as a 'substitution'[5] for some more grandiose fantasy, whilst within Tolman's theory of "purposive behaviorism", an interpretation of the same act might be that it provided the only available means of tension release. The 'actor' meanwhile, for his own peace of mind, may identify only the most altruistic possible of motives.

Simply by the introduction of adaptation as a tool of analysis, it can be seen that even those theories which make the most stringent denials of consciousness, affect or attention, refer to all of them in fairly obvious ways.

For example, the insistence by Watson[7] that learning is nothing more than movement of muscles and behaviour the result of conditioned reflexes only, with the intervention of nothing so mentalistic as instinct, seems at the very least odd, when his famous phrase "frequency and recency" is so reminiscent of adaptation and attention given to current happenings. The very notion of habit formation and the building up of stimulus - response bonds which require intermittent reinforcement[8] for their maintenance, is in itself highly suggestive of instinctive responses to current conditions and of continuing to behave in a certain way only so long as conditions demand it.

3.2 Need for Focus

If what has already been said fails to convince that even in cases where theorists make no mention at all of affect, arousal, adaptation, or other aspects of what is being called APM-A, that it must still be dealt with - either by assuming the process and thereby not having to refer to it directly, or, by simply denying consciousness altogether - it would be difficult indeed to deny the need for a signal to be noticed, or a problem to be acknowledged in order for it to act as a stimulus.

Even Guthrie's one objective law of learning which stated,

> A combination of stimuli which was accompanied by a movement will on its recurrence tend to be followed by that movement.[9]

was reformulated in the year of his death to deal with the need of the organism to select the physical stimulus to which it would attend. It became,

> What is being noticed becomes the signal for what is being done.[10]

Those theorists who apparently ignore the need to explain that a signal has to be registered before it can be acted upon are nevertheless usually forced to make some concession to the process of selectivity, discrimination of stimuli or the need to maintain interest in an already selected stimulus. Guthrie in fact refers to "maintaining stimuli"[11]. Watson's answer, as already noted, was a highly adaptive one; and Thorndike's formulations of which events are likely to produce learning implicates emotion, and thereby subjectivity, in an even more obvious way than Watson's unavoidable concession to instinct which, as will be explained, also operates through emotion. Thorndike's law of exercise and law of effect and the use of language such as "stamping in" and "stamping out" of responses appeared suitably mechanistic at the height of Behaviorism, but the introduction of the terms "satisfiers" and "annoyers" constituted an unfortunate reference by a connectionist to the crucial role of emotion in directing attention.

Thorndike's concessions to the act of focusing attention on a signal are evident both in his postulate that actions which result in successful outcomes are likely to be repeated (implying that the reward of success has the effect of focusing attention by discriminating certain actions from less rewarding ones), and in his subsidiary law of 'set', or expectancy, in which signals are intepreted according to the circumstances in which they have been met on previous occasions, again suggesting a narrowing of the field of vision - or focus.

Not even Skinner's[12] rejection of mentalistic and cognitive explanations of behaviour stands up to scrutiny in the light of "operant strength" being dependent upon positive reinforcement, i.e. reward.

Although there is no formal place for drive or motivation in Skinner's system, and certainly no place for attention, perception or expectancy - which, it has already been argued (2.4), are intimately related to arousal - as prerequisites for the shaping of behaviour, logically, dependency on reward constitutes admission of emotion and cognition in attention and learning.

Clearly, if operant strength is increased by reinforcement, the implication is that for a particular signal to be acted upon in a certain way, rather than behaviour being elicited by a different signal - or in fact the same signal eliciting different behaviour - reward must have the effect of creating preferences, in order for appropriate discrimination between signals to take place. A signal must be recognised as relating to previous similar situations and attended to in order to gain expected reward.

As might be expected, in view of the fact that so many theorists assume focused attention, in order for the illusion of a degree of objectivity in learning to be maintained, even fewer are interested in attention as conscious or unconscious scanning prior to signal recognition.

Guthrie, in his revised law of association, did however make particular mention of attention as scanning in his eight "assumptions" of what takes place in associative learning: paraphrased by Hilgard and Bower he states,

> When two cues that have been associated with incompatible movement patterns are both present, action is witheld and the movements involved in attention become pronounced including that which may be called scanning.[13]

Earlier than this Tolman[14] cited "vicarious trial and error (VTE) behavior" at choice points. VTE referred to the hesitation, vacillation and comparison of alternative stimuli by the animal before making a choice. Importantly in this context, Tolman regarded this active scanning, comparison

and discrimination as support for the view that perceptual-cognitive processes dominate behaviour at choice points.

Most obvious reference to scanning and focus, at an earlier date still, must be that of Pavlov[15] whose identification of the orientation reflex or "reflex of curiosity", was recognised as having obvious adaptive significance both in preparing the organism for swift action in the event of an emergency, and in the process of habituation which prevents repeated orientation to monotonous signals. Significantly, Pavlov's early physiological terminology for these reactions to stimuli was "excitation" and "inhibition".

Functionalist psychologists have been the only identifiable group to have been dominated by interest in investigating the mind in the context of adaptation, and it was the functionalist Woodworth[16] who identified the concepts of "situation-set" and "goal-set", of which the former refers fairly obviously to the importance of phenomenological change in the environment.

Situation-set, mentioned above (2.2), refers to adjustments to environmental events, while goal-set refers to inner 'steer' towards a particular goal: concepts which could easily be interpreted within the perspective being offered as scanning and focus respectively. Woodworth was also the first learning theorist to give prominence to the ideas of motivation and drive in a theory which described a cycle of activity and quiescence as "preparatory" and "consummatory" reactions. In fact he identified two kinds of preparedness, the first occurring as alert attention, "a condition of readiness for a yet undetermined stimulus that may arouse further response," and the other as evoked, "when the mechanism for a consummatory reaction has been aroused and is in activity."[17]

Berlyne[18] has related these actions to an initial general desynchronisation of biochemical activity within the cortex, which can be detected by means of EEG (electroencephalogram) recordings. He adds that many

writers, both Eastern and Western, have suggested that the orientation response is in some way essential to structural changes which underlie learning.

3.3 General and Specific Arousal

In evolutionary terms general arousal represents the most primitive reaction to changes in the environment of an organism. Just as an infant will attend naturally to events which possess a high rate of change in their physical characteristics, i.e. "Stimuli that move, have many discrete elements, or possess contour contrast,"[19] so do primitive creatures also respond to environmental change. Cotman and McGaugh on habituation and sensitisation[20] quote description and comment on the reactions of the marine polyp, a creature with only a "primitive nerve net", but which displays what is referred to as, "... one of the most pervasive phenomena of the animal kingdom "[21]

> If a drop of water falls on the surface of the sea anemone, the whole animal contracts vigorously. If, then, a second drop of water falls within a few feet of the first, there is less contraction, and finally, on the third or fourth drop, the response disappears altogether.[22]

Evidence of how primates respond to change could be culled from many sources, but Luria's descriptions[23] of the effects of brain lesions in surgical cases serve to illuminate Berlyne's comments (3.2) as well as giving a physiological basis to Woodworth's two kinds of preparatory reactions.

Luria in fact describes in detail the effects of brain lesions in both the limbic region (the very oldest part of the brain) and in the cortex. Damage to the limbic region disturbs what he calls the "primary basis of attention," i.e. the primary orientation reflex, which can be compensated for to some extent by offering the subject verbal instruction.

Pathological conditions of the cortex, however, lead to what he calls "instability of the physiological basis of attention," and this kind of damage to cortical regions he describes as affecting "higher forms of attention", which is, incidentally, much worse in cases of frontal lobe damage which results in gross disturbance of goal directed behaviour.

Clearly, in referring to "higher forms of attention" Luria is referring to its cognitive aspects, and specific identification of signals (focus), whereas the "primary basis of attention" located in the most primitive area of the brain is what is referred to as general arousal or heightened awareness associated with scanning activity, or Pavlov's "What-is-it? reflex".[24]

The identification of mid brain and cortical involvement in attention also gives a physiological basis to Schacter's two factor attribution theory of emotion [25] which is mentioned here, together with Luria's findings and the postulations of Berlyne and Woodworth, to help clarify the relationship between cognition and affect. The conclusion being drawn is that in the case of cognition, arousal is present but not predominant, or mostly even consciously identifiable, which is in contrast with our experience of emotion in which physical disturbance plays a much greater part, and whose cause is usually so 'obvious', or 'identified' so rapidly, for it to seem instantaneous, and for cognitive factors to be usually discounted.

Schacter's two factor attributional theory of emotion following Schacter and Singer's earlier research into cognitive, social and physiological determinants of emotional state[26] supplements Cannon's earlier arousal theory of emotion [27] with attributional concepts, as well as offering an explanation of how differentiation between emotions is made.

Schacter and Singer interpreted their research findings as showing that emotional experience results from the following sequence:

a. There is bodily reaction. (arousal)

b. The individual becomes aware of this reaction.

c. There is need to seek a reason or explanation of the reaction

d. An external cue is identified, and the internal reaction is labelled. This labelling provides the quality of the emotion.

general ↓ specific (localised cortical arousal)

(The present author's underlining and references to arousal)

The stages identified by Schacter and Singer with reference to emotion might equally well apply to what we refer to as cognition,

arousal (a)
↓
awareness (b)
↓
need for explanation (c) which might also be called need for reduction of ambiguity
↓
labelling (d)

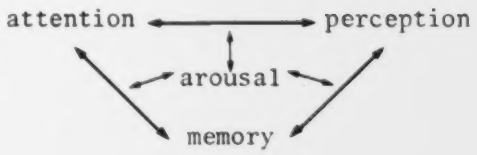
general ↓ specific

In turn this is remarkably similar to what has been described in the previous chapter as a learning process, except that instead of the linear model, which in the terminology of this paper would be

arousal
↓
perception
↓
attention
↓
memory (as recognition, registration and availability of 'labelling' for possible recall)

the model adopted here is an interactive 'feedback' model:

(Figure 1 p.4)



Obviously to include the general ——— specific dimension of arousal it would be necessary to introduce a third dimension into this diagram

a model which accounts for the rapid interaction of these aspects of the learning process as sub-threshold levels of consciousness, as already explained (1.1, 2.1, 2.5, 2.9-2.94). Such processing goes on so rapidly, often taking only milli-seconds to complete, that our only conscious experience is of apparently 'instantaneous' labelling or recognition. Where ambiguity persists, a signal may be presented for more conscious and unconscious scanning, but if focus is not achieved before attention is required elsewhere, it may require a further period of unconscious scanning before a solution is reached.

The familiar can be 'instantly' located and identified, but the less familiar may be given several possible identities before final satisfactory classification.

The only predictable sequential order of events admitted here is within the conscious ——— unconscious dimension, which could be set down as follows:

Figure 5 overleaf

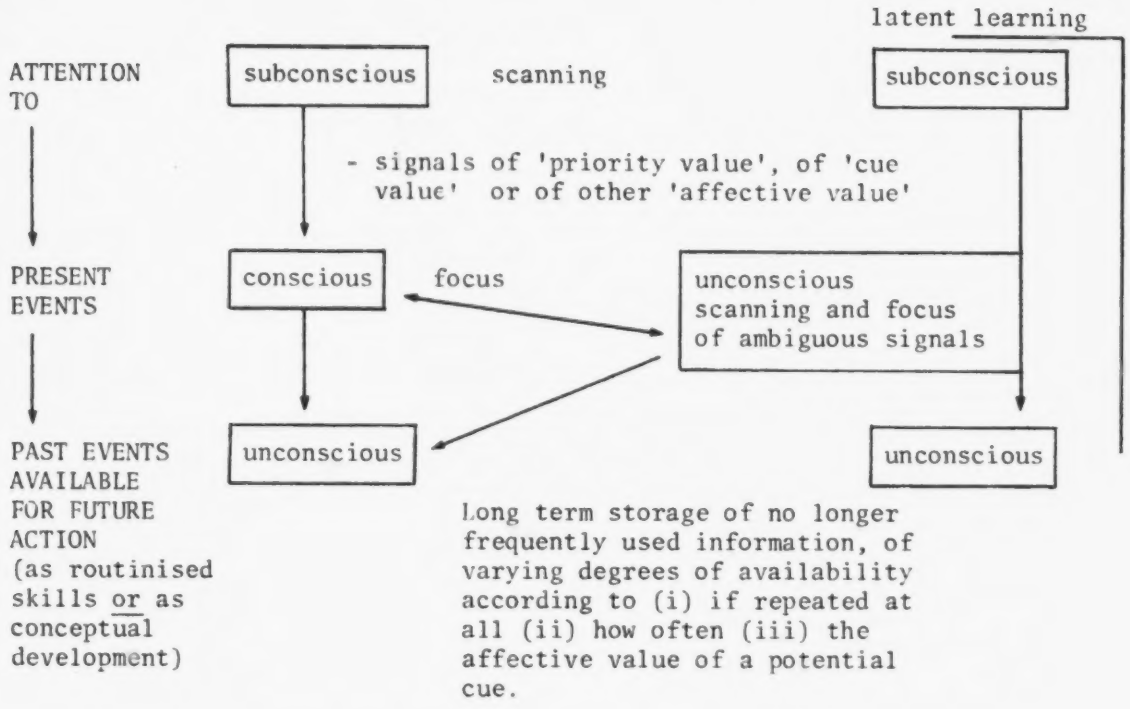

latent learning
ATTENTION TO
subconscious
scanning
subconscious
- signals of 'priority value', of 'cue value' or of other 'affective value'
PRESENT EVENTS
conscious
focus
unconscious scanning and focus of ambiguous signals
PAST EVENTS AVAILABLE FOR FUTURE ACTION (as routinised skills or as conceptual development)
unconscious
unconscious
Long term storage of no longer frequently used information, of varying degrees of availability according to (i) if repeated at all (ii) how often (iii) the affective value of a potential cue.

Figure 5 A temporal order of conscious and unconscious events of attention within which APM-A operates at all levels, and which encompasses attention given (consciously), and attention gained.

See also Figure 2, (1.24) and Figure 4 (2.93)

3.4 Hedonistic Motivation

The main theme of this paper is the interactive nature of affect and cognition - feeling and knowing - and it has already been argued that to separate one from the other is both artificial and misleading as affect is present at the very moment of perception.

In short, it has been argued that, the influence of affect on the phenomenological selection of environmental events to be attended to is inevitable because selection takes place according to a hierarchy of priority values. This is dependent on the interaction of the developed purposes of the individual (what the individual specifically wants) on the one hand, and the instinctive 'purposes' of Homo sapiens (what the organism actually needs) on the other: both of which influences imply that motivation focuses attention.

At its most primitive, motivation arises from the instinct to survive, so that reactions to environmental stimuli may be quite simple, perhaps just a matter of approach - in reaction to a second priority (procreative) signal (see Figure 3, 2.92) - or avoidance of danger heralded, say, by the kind of high pitched noise (and first priority signal) we have all come to associate with something approaching fast and in our direction. Both kinds of reaction are dependent on "what feels good" or "what feels bad": on the kind of innate information identified by Lorenz.[28]

To resort to the varnacular, with the excuse on this occasion that its imagery is appropriate to the discussion of continua, such behaviour could be described as 'high' on emotion and 'low' on cognition, terminology which emphasises that emotion and cognition are not mutually exclusive. Obviously the recognition of third priority signals associated with more complex interests - which become third priority only in the unlikely event of threat (first priority), sexual opportunity (second priority) and other interesting signals coinciding - requires that cognition plays a much greater part.

Contiguity theorists in striving for objectivity, and disregarding individuality, can only allow for learning which is to do with the 'here and now' and dependent on direct reactions to pleasure and pain as described above. For that very reason the notion of adaptation cannot be avoided, but within the bounds of contiguity theory only very narrow and direct needs, which don't demand the mediation of cognition, can be served. Responses which are evoked from the organism allow for no subtlety of purpose, no planning activity, no autonomy, nor any active choice by the subject from a possible range of rewarding alternatives.

As put by Hilgard and Bower in discussion of Guthrie's work,

> ... he doesn't in fact deny insight, purposive behaviour or problem solving, but his problem is to show how these forms of learning need no new principle beyond the simple law of contiguity.[29]

Even theories which depend on positive reinforcement or reward can offer only a passive view of man, a view of a being with no capacity for conscious decision making, only a capacity for making, or more accurately - having evoked - primitive hedonistic responses. This position is best illustrated by B F Skinner, whose book Beyond Freedom and Dignity[30] calls for a "science and technology of behavior" in which free will has no part.

The position adopted here, however, is not that some kinds of motivation are hedonistic and some are not, but that some are more hedonistic than others.

Many theories of learning link hedonism to some kind of homeostatic conception, so that pleasure is seen to be derived from events which return the individual to a state of equilibrium. Drive reduction and tension release are therefore viewed in themselves rewarding. For Hull as well as Freud, all internal stimuli are unpleasant,[31] and are to be eliminated so that behaviour is seen to be a function of temporary and fluctuating states of the individual. The theories of Hull, Spence[32] and Miller,[33] in fact, all view the rapid diminution of drive as reinforcing.

It is particularly interesting in our context that for Hull, in whose theories the concept of drive is crucial, drives have three functions. They select stimuli; they energise; and they steer behaviour.[34]

Although Tolman's position on tension reduction, as a Behaviorist who accepted cognitive concepts is very different from that of Hull (he believed that learning is used and purposes sought when states of tension arise, and that tension is expressed in a demand for goal objects), Tolman nevertheless also links arousal and the focusing of attention in a similar way to Hull. For Tolman though, demands lead to activity, guided by expectancies and cognition.

Despite the fact that later cognitive psychology has derived much from the thinking of Tolman, not all cognitive theories of learning have a concern with homeostasis, but a hedonistic interpretation can still be placed on

them. It has already been argued that recognition and preference for the 'good Gestalt' reduces ambiguity and anxiety, and Berlyne's emphasis on the role of curiosity in reducing 'conflict'[35] has obvious hedonistic overtones. For Berlyne curiosity represents instinctive exploratory behaviour which has both short term and long term survival value.

Curiosity, called by Bruner[36] "a prototype of the instrinsic motive", at its most primitive is instinctive, and therefore within the perspective offered here, emotional. It is, as attention is, an orientation reflex. Indeed Pavlov's alternative name for the "What-is-it? reflex" was the "curiosity reflex" but it is also known as general arousal and associated with the most primitive region of the brain. Here, it is suggested that Bruner's "intrinsic motive" and what Berlyne calls "epistemic curiosity"[37] are not instrinsic per se, but depend for their development upon an accumulation of sensory experience which, in turn, produces concept building and the ability to manipulate ideas. Together, these are necessary for the development of general interests and specific purposes, of which "epistemic curiosity" is only one.

Within the Piagetian analysis[38] of child development attention shifts from an "exercise" stage, and early motor development, to what is referred to as a stage of "physical experience" - by which Piaget meant a stage of extracting information from the environment - until finally the child is able to indulge in "logico-mathematical" experience, which depends on quite highly developed cognitive structures and the capacity for a high degree of focus as well as scanning ability. Similarly, in evolutionary terms, our evolved capacity for "higher forms of attention"[39] allows for specific focus of attention and the development of extremely complex, even quite abstract, intellectual, purposes. Although Piaget is not alone in stressing the importance of sensory-motor experience, his emphasis, along with that of theorists such as Montessori,[40] is different from most other psychologists

in that he recognises the value of sensory education and sensory 'nourishment' in promoting thought and interests: notions supportive of the position adopted above (2.8), with the only difference being the belief being expressed that sensory education and 'nourishment' can take place in adulthood - to similar effect.

Very simply, within the APM-A view, drive is regarded as general arousal associated with the orientation reflex and the activity of lower centres of attention situated in the oldest structures of the brain: a general state of arousal in response to changes detected by interceptors or exteroceptors. This concurs with a definition of drive by Borger and Seaborne, as "... a condition of disturbance of the organism without any necessarily associated goals for behaviour."[41]

Interests are being viewed as developing as a result of positively reinforced experience, and motivations as results of either, specific arousal, i.e. stimulated by specifically identifiable stimuli, or the experience of general arousal and subsequent focusing of attention; or, in the absence of survival demands (individual or species), or other priority signals, and in Tolman's terms,[42] fulfilling needs for tension release per se.[43]

Razran[44] has identified phylogenic levels of learning related to the evolution of the brain. His levels move from reactive learning through connective and integrative processes to problem solving. The evolutionary levels he names can be seen to relate very closely to stages defined above as occurring in the development of more complex motives and purposes in the individual. His stages are as follows:

A Reactive
B Connective
C Integrative
D Symboling

The relationship between connective and integrative learning (my brackets) and S-R learning, and between learning identified by cognitive theorists and integrative and symboling stages cannot be missed; nor can the association between the lowest level of Razran's stages (reactive) and what has been described in this paper as both the least focused kind of attention (sub-threshold scanning) and the most primitive kind of arousal, i.e. the orientation reflex.

It has been suggested already (hierarchy of diminishing interest, 2.92) that without 'purpose' or interest, the human organism merely reacts, either to first or second priority signals (Figure 3, 2.92), associated with survival purposes, or - for want of a better term - trivia, because the individual has not been exposed to, or particularly affected by, other kinds of experience likely to lead to the development of focused interests or more complex purposes than his own immediate survival needs, or the particular demands of the 'here and now'.

In this chapter, the concepts of attention, perception, arousal and emotion have been defined as unavoidable concepts of learning despite being ignored by some major learning theorists. Emotion and cognition have also been linked by means of an adaptation of Schacter and Singer's model of emotion (3.3) and an APM-A definition of motivation as developed 'purpose'. This corresponds with Homo sapiens' evolved capabilities, but is dependent on sensory education and above all sensory 'nourishment', which, it is stressed here, does not have to take place in childhood.

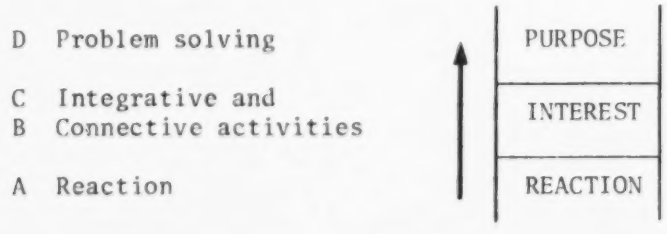


Figure 6 A hierarchy of developing purpose as an application of the hierarchy of diminishing interest (2.92), related to Razran's phylogenic levels of learning.

The figure above illustrates the possibility of a 'hierarchy of developing purpose' directly related to the evolution of the brain, but dependent on the acquisition of a rich store of sensory experience of the kind described in chapter 2 (2.8), in order to utilise evolved capacity of mind for more complex 'purposes' than those directly concerned with individual and species survival; or beyond what McLean, quoted by Meldman in describing the function of the oldest regions of the brain, refers to succinctly as "... the four Fs: feeding, fighting, fleeing and undertaking mating activity."[45] Rather more soberly, he continues, "These structures further subserve homeostatis, the stability of the internal environment, and regulate basic processes involved in the survival of the individual and the species."[46]

4 ATTENTION AS VIGILANCE

4.1 Man as Monitor

In discussing man's vulnerability within the total environment it has been argued that, above all else, we are 'tuned to change' (2.2): that we are necessarily distractable, both in order to be able to avoid potential danger and to take opportunities to satisfy our various appetites associated with physiological needs. It has also been argued that our attention is gained according to a hierarchy of signal values (2.92) directly related to individual and species adaptation. This rests on the likelihood of most strong and predictable reactions being elicited by signals associated with potential danger or opportunity to mate - or signals having 'cue value' (2.5), being associated with either - and only in their absence, or in extreme circumstances, by normally lower priority signals relevant to other immediate and/or conscious needs and purposes.

Within this view of attention, as dependent on reactions to environmental events according to the interaction of physiological and mental states, some degree of affectivity is seen to be inevitable as emotion has also been linked to arousal, particularly as described by Pavlov as the 'What-is-it? reflex' (3.2). It has also been reasoned that arousal depends on at least some measure of cognition, even if only in the form of what has been called species learning (2.4), just as cognition is seen to be dependent on affect (3.2).

However, our necessary distractability and responsiveness to change would not offer even a reasonable chance of survival if it were not for our ability to be vigilant, when given reason to expect a 'significant' event, and maintain attention when not to do so would be to expose ourselves either to self-inflicted harm or pose threats to others (which, as we all learn sooner or later, quickly results in threats to self).

Quite obviously, in the performance of tasks attention is required. Even when tasks have become 'overlearned'[1] to the extent of being performed for the most part unconsciously, when prolonged effort is required and the task is a tedious one, increasing difficulty is experienced in maintaing concentration. We frequently find ourselves in situations in which attention is neither gained directly by instinct nor given voluntarily merely to occupy time or unused attention capacity (2.92); and even in such cases as it has been given or gained initially, interest may well flag even before a self-imposed task is finished, so that further concentration requires special conscious effort.

Paradoxically, even the will to survive often involves complex, tedious or dangerous activities. Not only are many paid post-industrial revolution occupations complex, tedious and exceedingly dangerous, but in the natural habitat opportunities for self-mutilation and possible death abound. The simple hewing of wood, whittling of sticks and fetching of water are potentially lethal activities without due care and attention to axe, knife or stream.

It is surely this requirement to attend, imposed by physical or social needs and demanding of conscious effort beyond the point at which interest flags, which differentiates work from play. Certainly, without the capacity to focus attention and sustain effort beyond the exigencies of avoiding danger, or undertaking other more positive survival activities (the "4 Fs," 3.4), very little would be achieved at all. Stroh makes this point by saying

> ... there would be no knowledge and no civilisation if man did not have the ability to focus and maintain attention.[2]

Also in his introduction to vigilance research, and just as relevant to the discussions above about attention as instinct, relationships between the senses, perception and understanding (2.8), and the role of attention

in the development of purpose (3.4 and Figure 6), he says,

> Knowledge is derived from the analysis of physical properties of our environment - how things look, feel, smell, sound and taste. The employment of physical characteristics in the assimilation of knowledge depends on our ability to discriminate among stimuli.[3]

Jane Mackworth offers the most extensive review of research into vigilance between 1950-1970. In two publications she ties the vigilance research during this period to neurophysiological findings.[4] In the second of these[5] her interdisciplinary approach is actually extended beyond the mere combination of neurophysiology and experimental psychology to the employment of a mathematical signal detection approach to the interpretation of results.

Significantly, in the light of all that has already been said about individual purpose and phenomenological conditions which affect the decision to attend or not, the basic assumption of signal detection theory is that there is no absolute threshold above or below which a signal will be detected or not, but that the subject operates on his or her own criteria, striking a balance between 'cost' and 'reward'[6] to the organism.

Broadbent[7] devotes a chapter of his seminal work Perception and Communication to the subject of vigilance and gives an overview of research up to that date (1958), but a more recent review of vigilance research and theories has been made by Stroh[8] who, in turn, draws attention to other reviews and theories conceived between 1960-1966.[9] Kahneman, in his exposition of his theory of attention and effort,[10] also devotes a chapter to 'Focused Attention' and resistance to distraction, in which his references to vigilance research centre mainly on dichotic listening tests and 'shadowing' experiments of the kind initiated by Cherry[11] and Treisman.[12] More recently still, Shiffrin and Schneider give brief summaries of a number of models of 'search and detection'[13] and review more general theories of

attention in their paper on 'Perceptual learning and automatic attending'.

Vigilance research developed as a specific area of research into attention largely because it employs tasks in which some 'vigilance decrement'[14] may be observed. The vigilance task was originally devised by N H Mackworth[15] in 1950 when it involved the subject taking part in extremely monotonous tasks of detecting temporally irregular signals. One or the original tasks employed was the 'clock test', in which the subject had to observe a clock hand for two hours at a time, in order to detect irregular 'jumps'. The inevitable fall in the proportion of correct detections constituted the 'decrement'.

However, many different kinds of vigilance task have evolved since Mackworth's early definition, and as early as 1963 James McGrath bemoaned the fact that even over a period of 15 years more than one hundred investigators had published research papers on the subject of human vigilance, thereby producing a "profusion of research techniques". He concluded that, "the question arises of whether or not we are all studying the same phenomenon".[16] Despite the fears of McGrath, in all the research up until 1963, and even more since, certain consistencies have been identified.

Within the APM-A context it has been suggested that we learn phenomenologically in circumstances in which we are affected, either because events are related to something previously experienced or known, thereby creating a need to update 'cognitive maps',[17] or because the information or events in question hold some kind of 'emotional' significance. Certain key concepts have emerged which refer both to attention gained instinctively (chapter 2) and attention given or directed by more or less conscious motivations (chapters 2 and 3).

The general summary of major aspects of learning subsumed by the APM-A model which has already been offered under the three headings of adaptation, motivation and feedback (2.9), may now be extended in a way which is

relevant to all three:

	i	reaction to priority signals	(2.92)
adaptation (i-vi)	ii	hedonistic motivations	(3.4)
motivation (i-vi)	iii	responses: according to expectancies and iv, state of arousal	(2.4, 2.6, 3.3)
feedback (i-vi)	v	dependency on feedback (as outcomes of initial reactions)	(2.2, 2.5)
	vi	susceptibility to habituation	(2.5, 3.3)

For any who subscribe to the view that in practice affect and cognition are totally inextricable; and that human ability to learn derives from an imperative to adapt to and survive organic changes within ourselves and our physical, social and cultural environments, findings and theories which relate to vigilance research come as no surprise. Vigilance researchers reveal a high degree of match between the APM-A definition of what are key concepts as set out above and the results of enormous amounts of experimentation. There are in fact vigilance theories which relate directly to five of the six concepts underlined and, although a synthesis has already been offered by Stroh,[18] the APM-A construct not only allows amplification of what he describes, as will be shown, it also holds very different implications. Whereas Stroh calls for further scientific research in order to define laws, the APM-A explanation offers a tool for understanding individual situations and individual organisms, and it accepts as a fact of life the variables Stroh would seek to eliminate.

4.2 Cost and Reward

If it is accepted that motivation to learn is always to some extent hedonistic (3.4) and that attention is crucial to learning, one might expect to find that similar hedonistic motivations dominate attention theories, in which case it would also seem reasonable to expect some

reference to the concept of arousal.

In fact, three vigilance theories are of particular interest because of their concern with motivation, and all of the major theories make at least oblique, if not direct reference to arousal.

Signal Detection Theory, already mentioned in this chapter as used by Jane Mackworth in her interpretation of experimental findings in psychology and neurophysiology, is a mathematical theory of decision processes in visual detection tasks. It was first associated with Tanner and Swets[19] and Swets et al.[20] who were critical of simple 'percentage detections' as a suitable means of determining detection efficiency, primarily because such measures do not allow the inclusion of data about false detections.

By including data about all kinds of responses the hypothesis already mentioned above, i.e. that no absolute threshold exists above or below which signals will be detected or not, but that criteria exist within the organism, could be developed. If missed signals are deemed 'costly' to the subject the result is an increase in positive responses, but this incorporates a risk of more false detections; conversely, in the case of false alarms proving 'costly', the subject will respond positively to fewer signals and make not only fewer false detections but of course fewer correct reponses as well.

In Jane Mackworth's view repetition and monotony produce habituation of neural responses as a manifestation of reduced arousal, so that as it becomes increasingly difficult for the subject to attend the numbers of detections and false alarms both diminish.

Clearly, with its dependence on the shifting criteria of individuals, and relative costs and rewards to subjects of correct detections and missed signals, signal detection is not only concerned with hedonism and therefore, within the analysis offered here (3.3, 3.4), with arousal, but also with the concept of individually oriented scales of priority of what constitute

'significant' signals. This is also consistent with the concept of the 'hierarchy of diminishing interest' already developed (2.92).

Also of interest because of its undeclared connection with hedonism, priorities and arousal, but nevertheless obvious concern with expectancy, feedback and habituation, is Broadbent's[21] Filter Theory. It is based on the assumption that because the capacity of the human perceptual system is limited only certain incoming information will be 'adequately' attended to, viz. signals of the greatest physical intensity, signals of a high degree of novelty and signals related to 'drive states' of the organism.[22] Therefore habituation is seen to be the result of repeated observations reducing the novelty of a particular stimulus so that other 'task irrelevant' stimuli can intrude. Although it is regarded here as only a partial explanation of the attention process and as offering a view of man as entirely passive, the overtones of hedonism, response to priority signals, and arousal hardly need elaborating in the wake of all that has been said so far. In fact Broadbent suggests, after discussion of vigilance research, that Filter Theory "requires supplementing with other principles, particularly those of expectancy and activation theory."[23]

The third theory and the one in which motivation assumes most obvious importance is Reinforcement Theory. Associated with Holland[24] and Jerison and Picket[25], it is directly related to operant conditioning and to the concept of providing motivation. It states quite simply that successful detection of a signal acts as reinforcement for the observing response, and direct evidence of the effects of reward and motivation on vigilance tasks has in fact been offered by many researchers. Mackworth[26] devotes a chapter to the effects of motivation on performance and includes a review of research directly concerned with reward, and Pollack and Knaff,[27] Sipowitz et al.[28] and Bergum and Lehr[29] have all confirmed what most would suspect, that vigilance performance is improved by offering monetary rewards.

4.3 Feedback

In their study of the effects of monetary rewards and motivation on signal detection, Sipowicz et al. combined experimentation into the effects of reward on performance with the effects of subjects being given knowledge of results (KR). Findings indicated that the effects of reward on subjects were more powerful than the effect of being given information about their performance of a task. Nevertheless KR made a significant difference to the overall percentage of missed signals. Results showed that the control group missed 24% of signals, subjects given KR alone missed 12%, those given reward alone missed only 8% and subjects offered reward and KR reduced their number of missed signals to 4%.[30]

Mackworth offers an extensive review of research into the effects of feedback on performance[31] and concludes that knowledge of results improved performance in the majority of experiments. In a significant juxtaposition of attention, affect and learning she points out that not only does knowledge of results (feedback) offer learning opportunities about the physical nature and temporal probability of the signals, as well as about the quality of the subject's performance, but that the motivating effect of KR also helps to maintain level of arousal.

4.4 Expectancy and Arousal

Expectancy theory, which states (a) that the previous stimuli and signals determine the observer's expectancy or prediction about future signal occurrences, and (b) that the observer's expectancy determines performance level,[32] explains the effect of KR as giving the subject information about the temporal distribution of signals.

The relationship between expectancy and arousal has already been explored above in the discussion of attention as instinct in chapter 2 (2.4, 2.6) and again with reference to general and specific arousal (3.3).

Interestingly in this context, in his review of vigilance research and theories, Stroh actually draws attention to the similarity between Expectancy Theory and Arousal Theory.[33] He says that Expectancy Theory, dependent as it is on the effect of repeated stimuli enabling temporal predictions of subsequent stimuli, reveals the problem of maintaining attention as one of maintaining a background of sensory input, and goes on to equate it with Arousal Theory.

Arousal Theory grew from Hebb's[34] suggestion a quarter of a century ago that stimuli serve both a cue function and an arousal function, so that such signals have information value and maintain the state of alertness of the subject. The implication of Hebb's suggestion is, therefore, that a greater variety of either task relevant or irrelevant stimuli results in smaller vigilance decrements. There has in fact been a great deal of vigilance experimentation to support this point of view,[35] and the availability of EEG recordings and other physiological measures such as blood pressure, pulse rate, respiration, skeletal muscle tensions and galvanic skin responses has led to a plethora of research which has served to emphasise two aspects of arousal: first, that it is not a unitary concept for which any one physiological measure is adequate and, secondly, that it involves both mid brain and cortical activity.

The first conclusion suggests a need to take the uniqueness of the individual into account. In the case of older adults this might mean accommodating the fact that base levels of arousal are likely to be lowered, so that more intense stimulation may be required in order to gain attention.[36] Conversely, because of possible desynchronisation of central and autonomic nervous systems in older adults arousal levels may quickly spiral to become dysfunctional.[37] The same deterioration in synchronisation could also cause a slower return to 'normal'.[38] The second conclusion - that both mid brain and cortical activity are involved - incidentally lends support

to Schacter and Singer's two factor attributional theory of emotion (3.3).

4.5 Habituation

Of the original six key concepts listed above (p 60) as being of crucial importance to the APM-A construct viz. priority signals, hedonistic motivations, expectancy, arousal, feedback and habituation, vigilance theories have already been identified which relate directly to all of them except feedback and habituation. In the case of feedback, although no theory relates directly to it in the way in which Signal Detection Theory, Filter Theory and Reinforcement Theory relate to the notions of priority signals, hedonism and arousal; or in the way that Expectancy Theory and Arousal Theory relate to key concepts of the same names, findings have already been discussed which indicate its importance in reducing vigilance decrement. Mackworth also makes the statement that,

> ... there is usually no decrement in a session with KR. These changes may be due to 1) learning the characteristics of the signal, 2) a prevention of the usual increase in caution, 3) reinforcement, or increasing the rewards of observing and penalties of non-observing, 4) the alerting and dishabituating effects of strong extra meaningful stimuli, and 5) other motivational effects which encourage the subject to try to keep himself awake.[39]
>
> (the present author's underlining)

Interestingly, she not only draws attention to the crucial relationship between feedback and degrees of arousal and habituation but, by making references to motivation, expectancy (learning the characteristics of a signal), and the value of meaningful signals, she also shows that analysis of feedback (see Figure 4, APM-A ——→ Verstand) can provide a link between all of the six concepts identified earlier.

By looking at Inhibition Theory, the final major vigilance theory which attempts to explain the phenomenon of habituation, further evidence can be found of the vital importance of the nature of the feedback a

subject receives from the environment. Inhibition Theory, the earliest of the vigilance theories, was conceived by the pioneer of vigilance research N.H. Mackworth who, as early as 1948, perceived an analogy between vigilance decrements and extinction, a phenomenon of classical conditioning which occurs in the absence of either the unconditioned stimulus or reinforcement. Mackworth developed his theory after witnessing the apparently dishabituating effect of a short telephone call - which he regarded as a novel stimulus - and subsequent restoration of original level of performance of a subject after half an hour on a vigilance task.

Just as Stroh sees a connection between Expectancy Theory and Arousal Theory, another possible interpretation of Mackworth's Inhibition Theory is that a phenomenologically novel stimulus increases arousal. This explanation actually fits most readily with descriptions of the neuro-physiology of the situation. In fact, support for an APM-A interpretation of habituation comes from Luria's description[40] of microelectrode studies, in which each response to a novel situation requires first and foremost the comparison of the new stimulus with the system of old, previously encountered, stimuli. He says,

> Such a comparison alone can show whether such a stimulus is in fact novel and whether it must give rise to an orientating reflex, or whether it is old and its appearance requires no special mobilisation of the organism. This is the only type of mechanism which can permit the process of 'habituation', so that a repeatedly presented stimulus loses its novelty and special mobilisation of the organism is no longer necessary. In other words, the mechanism of the orientation reflex is closely bound with the mechanism of memory.[41]

Of the five major theories now identified, Stroh equates Expectancy Theory with Arousal Theory, Filter Theory later became Filter-Arousal Theory[42] and, according to Luria's analysis of habituation, Inhibition Theory can be reinterpreted as dependent on the orientation reflex and activation - or not - of the organism; a process already explored in chapter 3 (3.4). It

has already been argued that Signal Detection Theory, together with Reinforcement Theory, are dependent on hedonistic motivation, on the value of signals and concomitant cost and reward to the organism. These phenomena, in Jane Mackworth's view, are also directly dependent on the neural arousal response, its habituation and possible reinstatement.[43] Thresholds for signals are lowered and raised depending on how much repetition or change occurs in the events which constitute the signal, and whether or not habituation is counteracted as, for instance, by direct reward producing motivation or by knowledge of results which may also be motivating. Jane Mackworth regards the latter as in itself arousing: "The motivating effect of KR will also help to maintain the general level of arousal."[44]

4.6 Synthesis and Augmented Synthesis

Stroh offers a synthesis of vigilance theories as IAF Signal Detection Theory[45] (Inhibition, Arousal, Filter, Signal Detection). He suggests that Filter Deviations (attention to internal events, such as day-dreaming, or task-irrelevant external events) result from extinction due to too few signals, or inhibition of neural responses and decrease in arousal as a result of many stimuli. In the case of there being too few signals to detect he further suggests that the activity of watching for signals is not very rewarding, and when there are too many signals they lose their novelty value. Stroh postulates that it is at this stage that arousal is seen to decrease as a result of inhibition of the observing response which, he says, often leads to more internal filter deviations (such as day-dreaming) and these in turn predispose towards low levels of arousal.

Stroh also suggests factors which may influence performance, such as age, degree of neuroticism, the subject, the phenomenon of 'time error'[46] - which he says could act to improve or worsen vigilance performance,

depending on the relative intensities of signals and stimuli - and stimulus frequency. He goes on to add that cautiousness about what constitutes a signal affects overall level of vigilance which, he says, has been observed as subjects gain more experience in a task. This could of course be reinterpreted as what Mackworth refers to as raising of threshold because of inhibition of neural responses; however, it is equally possible to offer an APM-A interpretation. This would assert that instead of cautiousness coming into play, the observer learns that the signal is not after all a priority signal, and that it has ceased to hold any potential threat or any potential reward and that this, in turn, leads to decreased arousal. It could be that what Stroh calls increased caution, is in fact decreased interest.

Stroh's answer to the question "Why do Filter Deviations occur?" is that "Filter Deviations occur as the direct result of both Inhibition and Extinction."[47] He defines decrease in level of arousal as a result of inhibition and extinction. These are seen to occur because of either lack of novelty of the signals or the fact that correct detections are not particularly rewarding.

The APM-A answer to the same question would be that deviations occur as a direct result of decreased level of arousal which causes inhibition and extinction, and that the reason for the decreased level of arousal is that the signal no longer holds affective value for the organism. Whilst not disagreeing with Stroh, or a plethora of research which suggests that lack of reinforcement and lack of novelty of the signal results in lowered levels of arousal (or, in slightly different terms, that they result in a raised threshold for the signal to have to encroach in order to activate the subject to a state of alertness), the inhibition of neural responses, as already noted in Luria's definition (p 67), represents a change in the interaction of attention, perception, memory and arousal.

What is suggested, therefore, is that a straight forward synthesis of existing theories is inadequate to describe and explain vigilance decrement, just as the same synthesis would be inadequate to describe other aspects of attention given and attention gained, which, as was stressed at the beginning of the chapter, can be shown to share key concepts with attention as vigilance (4.1): an exercise also resulting in learning - if only of the most basic possible kind. Even without knowledge of results, or more meaningful feedback from a vigilance task, an observer will at least learn that this novel signal is no longer novel and that it holds no exciting potential for him, or her, either as a member of the human species or as an individual, all of which lends support to a notion already hinted at, that an adequate theory of attention must also explain learning.

An APM-A interpretation of some aspects of learning theory has already been offered in chapter 3, and existent vigilance theories are referred to above. There remains however a body of more general attention theories. Space here will not permit even brief summaries, but they can be found most notably in the work of Moray,[48] Norman,[49] Meldman,[50] Kahneman[51] and Neisser[52] as well as in the Shiffrin and Schneider paper[53] already quoted (2.93).

Theories most often summarised are those of Broadbent (already mentioned as Filter Theory (4.2)), Treisman's modification[54] of Filter Theory, the theoretical considerations of Deutsch,[55] who refers particularly to the relative importance of incoming messages (2.3), the work of Norman[56] alone (2.93) and with co-authors, and the work of Kahneman[57] on attention and effort (see 1.21 and note 22).

Two of the above have identified the fact that more than one kind of information processing goes on at once. Although Shiffrin and Schneider state that the Norman model nearest their own does not identify "... the most important and necessary distinction between automatic attention learning

and controlled processing."[58] In his conclusion that top-down and bottom-up processing take place simultaneously (see 2.93) Norman nevertheless does identify the crucial fact that attention is not a simple unitary process.

Although all existent theories of vigilance performance, more general attention theories, and learning theories identify some of the phenomena of attention and learning, none of them explain all of the complex characteristics of attention identified in chapter 1, which, if the arguments concerning the APM-A model are accepted, logically also apply to learning. It is suggested therefore that, a theory of attention should not only be applicable to attention as vigilance, attention as instinct, and attention given or gained as a result of possibly very complex conscious and unconscious motivations, but it should also offer an explanation of all kinds of learning from routinisation of tasks and conscious memorising to complex conceptualisation.

Thus: it has been shown that the theoretical construct APM-A ———►Verstand (Figure 4) does accommodate existent attention and learning theories as well as allowing critical analysis of them. It can also accommodate variables, both in individual performances and in localised environments. Paradoxically, by not defining specifics, the APM-A framework does allow for the possibility of specific analysis of particular performances. The call by some for more scientific research into attention and learning in order to develop better theory implies more than just an optimistic belief that all variables can be eliminated; it implies a belief that such research could yield a means of prediction about an essentially unpredictable aspect of mental activity, concerned as it is with linking variables associated with both internal and external events.

Whilst not denying the value of empirical research under controlled conditions to increase knowledge - provided that results are viewed

critically - the hopelessness of trying to develop a 'scientific' theory of human behaviour is only fully revealed by considering how the human psyche, and particularly mechanisms which relate to the way in which attention is given and gained, have evolved. The evolution of the human mind is, in fact, a response to the phenomenological unpredictability of the environment in which it dwells: an environment composed as it is, among other things, of millions of other decision makers - of whom, in the twentieth century, any random sample may include incompetent builders, bad drivers, politicians, mad dogs, teachers, hijackers, doctors or the criminally insane, any of whom are likely to have a bold, but unpredictable, effect on attention. Moreover, in sum 'the environment' represents only a microscopic portion of a universe whose complexities and rhythms are hardly revealed, let alone understood. The need to cope with unpredictability and change is fundamental to the fact that as a composition of organic beings, the human race, together with the rest of nature is characterised not only by its adaptability, but by its variability.

5 SOME IMPLICATIONS

There is insufficient space here to explore and discuss fully the implications of the new perspective or to explain and emphasise the centrality of the perceptual process to human psychology in general. This is attempted elsewhere.[1] However, space here will permit a brief list of some of the implications of the APM-A model for teaching and for the concept of lifelong learning in particular. This is offered under four headings, paradigmatic, theoretical, methodological and practical, so that emphasis moves from some extremely broad issues to other very specific applications of the APM-A view to teaching and learning.

5.1 Paradigmatic Implications

5.11 The APM-A analysis suggests a need for a shift in balance, from the current cognitive bias in learning theory and educational research towards greater consideration of biological and physiological factors. It suggests a need for much greater recognition of the role of emotion in learning, and especially of the interaction of sub-threshold (of consciousness) and super-threshold reactions to environmental events.

5.12 Awareness of the highly interactive nature of affect and learning (as manifestations at different levels of consciousness of the APM-A process) also suggests a need for much greater critical awareness of directly or indirectly related empirical research which, in the often vain attempt to eliminate all variables, may still not take into account all of the complex aspects and dimensions of attention, perception, memory and arousal indicated by the model.

5.13 APM-A Verstand suggests that educationists should place emphasis on stage (of individual development) rather than age, as meaning

can be extracted only from material which is related to the already known or experienced, either as a result of 'species learning', or as the unique cognitive mapping of individual experience.

5.14 A life-long developmental view of learning which takes greater account of 'stage', and the uniqueness of the individual, than age, indicates a need for radical changes in curriculum design and assessment in both secondary and adult education. The implementation of relevant changes would hold the possibility of fewer secondary school pupils being 'schooled for failure' and consequently being 'cooled out' of the system - sometimes permanently.

5.15 The developmental view of learning described above suggests a symbiotic relationship between the development of 'person' and the development of motivation (see 3.4) which again brings into question many curriculum issues. For instance, the new perspective presents a powerful case for greater value to be placed on arts education and on other practical subjects in secondary and adult education (see 2.5, 2.8). It also emphasises a recognised need, especially in the university sector of adult education, to constantly re-assess whether or not courses are in fact accessible to students (of whatever age) in addition to being available, and for the inclusion in programmes of short, informal courses, and courses offering breadth of study as well as 'depth'.[2]

5.2 Theoretical Implications

5.21 Without appreciation of the complexity of what has been called the AFM-A process and its crucial role in all kinds of human development, theoretical formulations are likely to be limited on several counts. For example (a) only conscious and/or measurable aspects of learning may be accommodated; (b) 'accurate' perception and 'adequate' attention are likely

to be taken for granted; or (c) explanations of learning may emphasise either the acquisition of skills or the development of understanding, rather than taking into account the many different kinds of learning involved in individual development.

5.22 Concern with relationships between concepts associated with learning, rather than consideration of each in isolation only, offers an organic approach to theory in which new relationships can be identified, including those between mechanistic behaviour modes and expressions of 'higher order' needs.[3]

5.23 As well as offering identification of key concepts of learning (2.9, 4.1) APM-A Verstand offers some clarification of some commonly, but imprecisely, used terms. For instance, the terms motivation and drive, although deemed by some to have separate meanings, are frequently used interchangeably, whereas within the new perspective motivation can be seen to have a focusing (of attention) function, and only one drive (as a source of energy) is acknowledged, i.e. arousal[4] (3.2, 3.3, 3.4).

5.24 In emphasising the effects of the total environment on attention, affect and learning, the APM-A view also offers a theoretical underpinning to the need to be aware of the potentially crucial influences on learning of incidental and/or unplanned factors, in addition to those conventionally regarded as composing a 'hidden curriculum'.

5.3 Methodological Implications

5.31 Above all, the APM-A analysis identifies attention, affect and learning as aspects of a highly subjective process, and all environments as changeable. This lends support to the belief that, teachers who acquire as full an understanding as possible of the situations they may find themselves in,

on the one hand, and a high awareness of change coupled with a wide repertoire of teaching strategies for coping with new situations on the other, are better equipped than those subscribing to 'laws' or 'rules' of learning and teaching.

5.32 The fact that attention fluctuates - but not randomly - suggests that to gain attention, or even maintain attention already given, is a phenomenological problem, i.e. that it is not sufficient for a lecture or course simply to have an arresting beginning: constant monitoring and adjustment to feedback is necessary.

5.33 Understanding of the APM-A process is seen to hold implications for all levels of decision-making about teaching and learning: as a tool for early diagnosis of learning problems as much as for potential influence on course planning.

5.34 The importance, in learning, of the state of arousal of the individual[5] indicates a need for some tension to be created in teaching/learning situations (most simply, in terms of student participation), but it also draws special attention to the risk of creating anxiety, to the detriment of effective learning.

5.4 Practical Implications

5.41 The APM-A view emphasises the value of the deliberate use of attention devices as tools for more effective teaching and learning, not only in the design of visual aids, choice of methods, or the use of video or tape-recording equipment and other means of introducing variety and sustaining attention, but also from deliberate changes of pace and modulation of voice in oral communication, to selecting and ordering of course content - and being prepared to change order if necessary.

5.42 The new perspective emphasises the necessity for concern with individual differences beyond usual concern with differences in educational and social background or age, or even cognitive style and personality: it emphasises the need for awareness of total, and therefore changing, mental and physical states of individual organisms.

5.43 Concern with total states of individual organisms within the APM-A context, which stresses the importance of the senses in learning, also emphasises the need for awareness of the possibility of impairment or decline of sensory acuity in older students in particular.

5.44 The APM-A analysis indicates a need to consider threshold and possible sub-threshold effects of distracting signals, including any which may be associated with physical discomfort which may result from more or less obvious factors, from poor ventilation or adults having to use chairs designed for children to the hazard of long teaching sessions without a break.

5.45 Vigilance research points up a) the desirability of breaks, even though the need may not be consciouly felt by teacher or students; (b) the necessity of specific feedback for most effective learning (however coy a teacher may be about awarding marks or grades); (c) the importance of pace, not too fast or too slow, if the twin evils of inhibition and extinction are to be avoided; (c) possible benefit of judicious use of positive reinforcement and reward (at its simplest, maintenance of eye contact, to more specific and overt reward of say, making use of student contributions) in order to maintain efficient levels of arousal; (e) the need for material to be structured, however flexibly, if the benefits of expectancy are to be reaped by students, and (f) the desirability of verbal or written

summaries of lectures in particular, as some habituation is likely to occur in most students.

5.46 Student awareness of vigilance research and the problems of sustaining attention could also result in better organised study.

NOTES AND REFERENCES

1 HIDDEN COMPLEXITIES

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2. Norman, D.A., Memory and Attention, Wiley, New York, 1976 (2nd ed.).

3. Dodd, D.H. and White, R.M. Jr., Cognition: mental structures and processes, Allyn and Bacon, Boston, Massachusetts, 1980, p. 395.

4. Ibid., p. 23.

5. Some links between environmental perception, instinct and cognition have also been made by Stephen and Rachel Kaplan in Cognition and Environment, Praegar Press, New York, 1982. Their view is generally consistent with the APM-A view, but their expressed aim was to link the fields of environmental psychology to that of cognitive psychology, rather than stress the role of emotion in cognition or any of the other aims of this paper.

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8. attention as selection: Underwood, G., Attention and Memory, Pergamon Press, Oxford, 1976, p. 268.

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9. Miller, G.A., 'The magical number seven, plus or minus two: some limits on our capacity for processing information,' Psychol. Review, 1956, 63, 81-87.

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11. Discussion of the prevalence and significance of these tendencies can be found in: Abercrombie, M.L.J., The Anatomy of Judgement, Penguin, Harmondsworth, Middlesex, 1969, pp. 132-143 and Argyle, M., The Psychology of Interpersonal Behaviour, Penguin, Harmondsworth, Middlesex, 1978 (2nd ed.), p. 107, respectively.

12. Underwood, G., op. cit., p. 208.

13. Berlyne, D.E., Conflict, Arousal and Curiosity, McGraw Hill, New York, 1960, p. 45.

14. Kahneman, D., Attention and Effort, Prentice Hall, New Jersey, 1973, pp. 2-3.

15. Mackworth, J.F., Vigilance and Attention, Penguin, Harmondsworth, Middlesex, 1970, p. 19.

16. Ibid., p. 20.

17. 'Priority signals' are defined in chapter 2 (2.92) as belonging to a 'hierarchy of diminishing interest'. Other terminology adopted in relation to this hierarchy includes 'priority value', 'cue value' and 'affective value' (2.5). Berlyne (op. cit. p. 61) uses the phrase 'affective value' to mean association with rewarding or punishing situations. Its use here also includes signals likely to elicit instinctive reactions.

18. McGinnies, E., op. cit., p. 408.

19. Hunter, I.M.L., Memory, Penguin, Harmondsworth, Middlesex, 1957, p. 239.

20. Ibid., pp. 231-248.

21. Hilgard, E.R., Atkinson, R.L. and Atkinson, R.C., Introduction to Psychology, Harcourt, Brace Jovanovich, New York, 1979 (7th ed.), p. 210.

22. Ibid., p. 161.

23. see Kahneman, D., op. cit., chapter 2, 'Towards a theory of mental effort', in which he examines the relationship between arousal, effort and attention, and discusses the measurement of effort by degree of arousal, with the implication that mental effort may be conscious or unconscious.

2 ATTENTION AS INSTINCT

1. Oatley, K., Perceptions and Representations, Methuen, London, 1978, p. 166.

2. This notion is explored in depth in Gear, J., Perception and the Evolution of Style: a new model of man, Routledge and Kegan Paul (in press).

3. The effects of levels and kinds of arousal on performance are explored in Gear, J., op. cit. (in press).

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5 SOME IMPLICATIONS

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2, 3, 4, 5. All of these points are more fully discussed in Gear, op. cit. (in press), in which proposals for radical changes in the education system are set out in chapter 6; a full discussion of 'higher order needs' and an APM-A hierarchy of needs is offered in chapter 2; and relationships between motivations and drives, and the crucial effects of states of arousal of individual differences, are explained in chapters 3 and 4.